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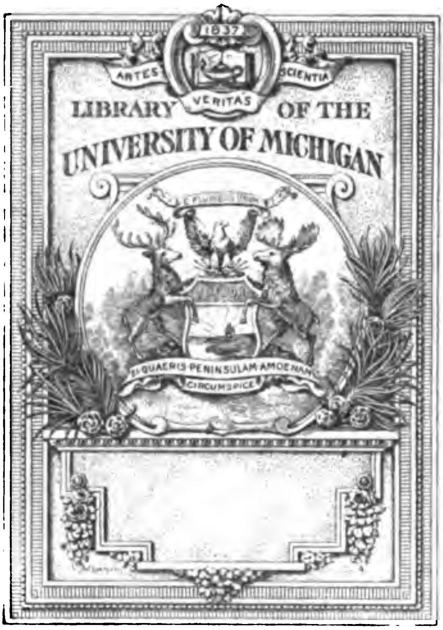

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 116 APRIL 1, 1908

STARTING YOUNG ORCHARDS

This bulletin contains notes upon culture and mulching; crops and cover-crops; pruning; spraying; insect and other enemies; and poultry in the orchard.

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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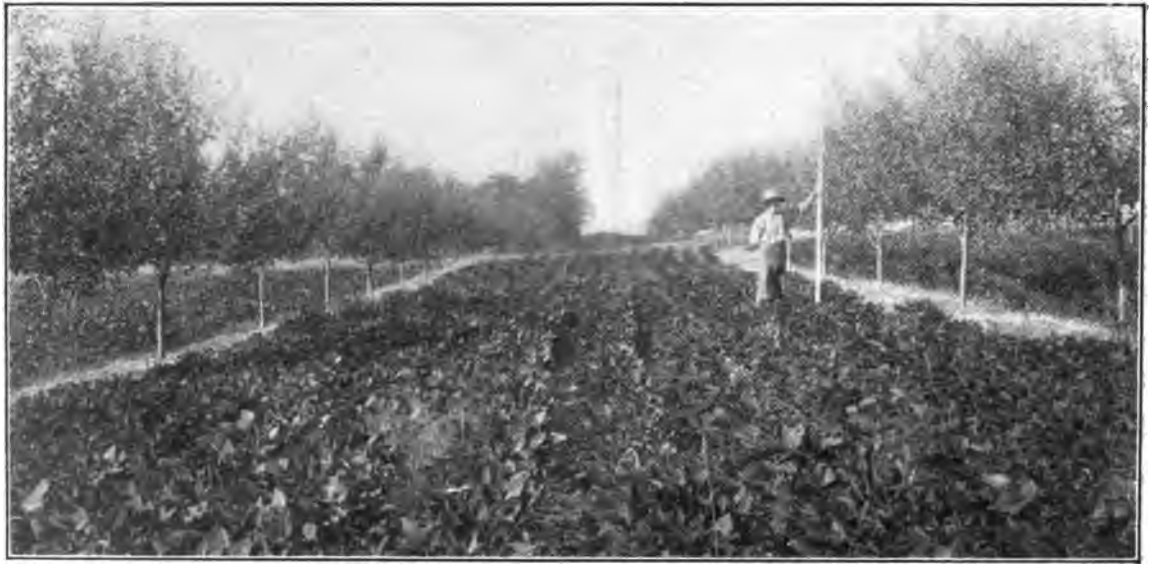

Figure 1. Young orchard under cultivation, showing cover crop.
(Courtesy *Rural New-Yorker*).

ORCHARD NOTES.

W. M. Munson.

Among the more important problems attendant upon the starting of a young orchard, are those of cultivation, mulching, cropping, winter-cover for the soil, pruning, and the control of insect and fungous enemies of the trees. To these may be added the question of pasturing; but, except as a run-way for poultry, the young orchard should never be used as a pasture. Orchards of bearing age, on rough or hilly land, may often be pastured to advantage with hogs or sheep.

Culture Versus Mulch.

There are strong advocates of both cultivation and mulching as methods of orchard management, and strong arguments may be advanced in favor of each. As a result of personal observation, extending over a period of more than ten years, the writer would favor cultivation upon those lands which are susceptible of culture, without unnecessary expense, and mulching upon all other lands. What that cultivation shall be, and what that mulch shall be, will of course be determined by local conditions, to be discussed later.[*]

In New York State, the questions of tillage as opposed to "sod-mulch" are being studied by the Experiment Station at Geneva. These investigations, which have been under way for four years, have been conducted in mature orchards, and thus far the results obtained show marked results in favor of cultivation and cover crops. It must be acknowledged, however, that the cost of cultivation is very considerable, and on many orchard sites cultivation is wholly impracticable.

By the advocates of "sod-culture" it is claimed that, by

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[*] For full accounts of the studies referred to, see Bulletins 89, 122, 139 and 155, Maine Agr. Expt. Sta.

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setting free too much nitrogen, cultivation renders the wood spongy and the fruit soft. It is also claimed, and not without apparent reason, that certain varieties, like Alexander and Yellow Transparent, which are subject to blight, exhibit a marked increase of this blight tendency under cultivation. This contention is supported by Mr. George T. Powell, himself an advocate of high culture.

There is no doubt that fruit from trees not under cultivation is of higher color, and usually of firmer texture. That it will always keep better in storage, however, has not been fully proved.*

The general principles involved in the two methods are very simple. In the mulching, the aim is to accumulate all of the vegetable matter possible in the soil; thus not only feeding the plant, but holding the moisture as well. Under cultivation, the organic matter is used as rapidly as possible and more is added in the way of cover crops and green manures.

CULTURE: WHY AND HOW.

The soil is a vast storehouse of plant food, and the first effort of the husbandman should be to make this store available to plants. Now a plant derives the greater portion of its food from the soil in the shape of solutions of inorganic materials. These solutions, in the form of sap, ascend to the leaves of the plant through the young wood, and then, by the action of sunlight, become changed into starch, sugar, etc., which are used in the repair and growth of all parts of the plant. The growth of the roots, therefore, is largely determined by the amount and vigor of the leaf-bearing surface; while the latter is also dependent upon the ability of the roots to secure the necessary inorganic elements.

As set forth by Professor F. H. King, of the Wisconsin Experiment Station, the objects of tillage are, briefly: To render the soil uniform; to increase depth of soil; to increase the amount of humus; to improve physical condition; to conserve and regulate soil moisture; to render plant food more available; to provide a sanitary abiding place, drained, ventilated and warmed, for the life processes incident to plant growth; and lastly to destroy weeds.

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* Bulletin 122, Maine Agr. Expt. Station, p. 200, 1905.

For practical purposes, the benefits of tillage may be concisely given under three general heads, viz.:

(a) Tillage improves the physical condition of the soil.
(b) Tillage conserves moisture.
(c) Tillage may augment chemical activities.

The chemical composition of a soil is not necessarily a measure of its productive capacity, since plant food is of no consequence unless the plant can make use of it. The Station chemist may tell what elements a given soil contains, but he cannot predict whether that soil will grow good crops. Every farmer knows that a hard, lumpy soil will not grow good crops, no matter how much fertilizer he may apply. Any clay soil may be so injured by one season's injudicious treatment as to render it comparatively worthless for several succeeding years; and it is useless to apply commercial fertilizers to lands which are not in proper physical condition for the best growth of crops, whether trees or grain or grass.

By fining the soil, and thus increasing the feeding surface of the roots; by increasing the depth, and thus giving greater foraging area; by warming and drying the soil in spring; and by reducing the extremes of temperature and moisture, the physical condition of the soil will be rendered most suitable for giving up the store of fertility contained therein.

As already stated, the food materials must be in solution in order to be of use in building up plant tissue. Now the amount of water which falls during the growing season is entirely inadequate to the growth of plants during that time. For this reason it is important that the water holding capacity of the soil be increased as much as possible, and that some means of checking evaporation be adopted. Both of these conditions are best brought about by tillage.

Naturally those soils which are most open and most porous, which contain the largest number of spaces between the particles, will retain the moisture to the best advantage and will give the best opportunity for the roots of plants to penetrate them and take up the moisture there stored—in the same way that a sponge will take up a larger amount of water than a block of wood. By deep plowing and thorough working, and by the addition of organic matter, either in the form of stable manure or as crops plowed under, this spongy condition is obtained. It is obvious, however, that deep plowing should be performed before trees are planted; and in no case is such practice allowable in an old orchard.

Having provided a reservoir for moisture, it is important that some means of retaining that moisture be provided; some means of conserving it for the needs of plants during the growing season. In addition to the continual pumping of moisture by the roots of plants, to supply the loss by transpiration from the leaves, there is constant evaporation from the surface of the soil. There is no better way to check this evaporation than by breaking the capillary pores near the surface by frequent shallow cultivation; in other words, by providing a blanket of fine, dry earth.

The value of tillage in aiding chemical processes can readily be seen. By opening the soil, admitting warmth and oxygen, the organic matter is rapidly decomposed, plant food is set free, and the development of the organisms necessary to plant growth is promoted. The simple statement of these facts is, perhaps, sufficient at this time.

In the management of orchard lands it is not so much a question of how the tillage shall be performed, as that it be given. For the first few seasons after the trees are set out, on land which is not subject to washing, fairly deep plowing, with a plow heavy enough to turn under heavy crops, weeds, etc., is advised. The heavier clay soils should be handled very carefully, to avoid puddling. In no case should such

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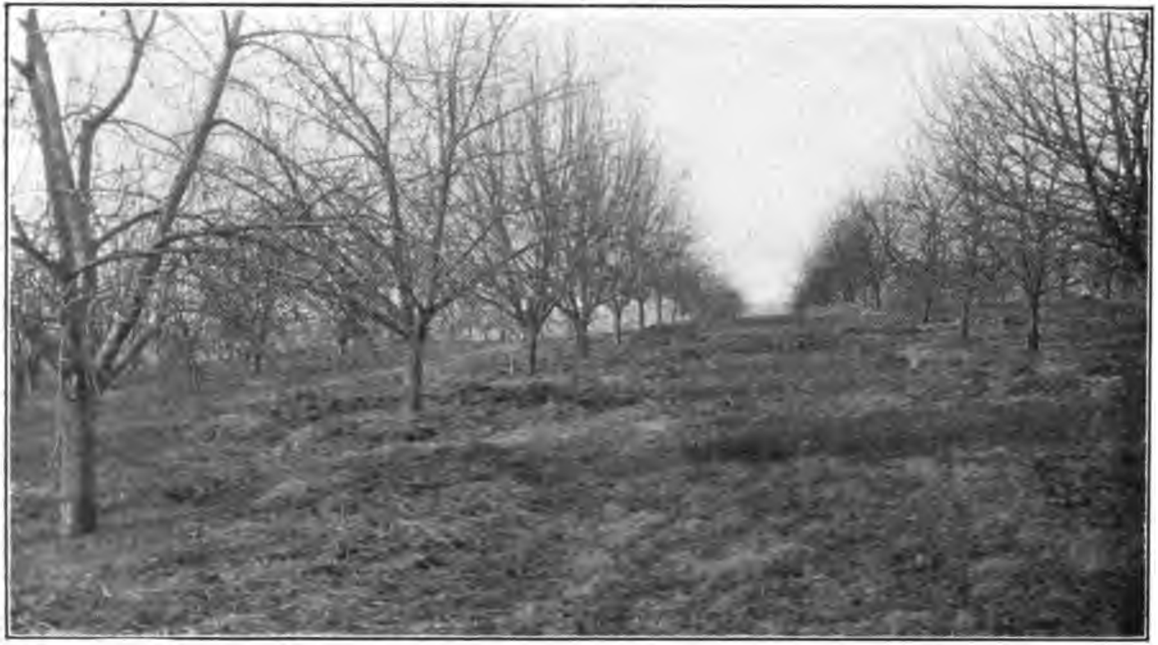

Figure 2. Straw-mulch in the orchard.
(Courtesy *Rural New-Yorker*).

soils be handled when wet. In the early part of the season, heavy implements. like the spring-tooth or the disc harrow, should be used; later in the season, when the object is merely to conserve moisture, the spike-tooth drag or the smoothing harrow should be substituted. Short whiffletrees with the ends protected by cloth, or better still traceless harnesses, should be used; and in no case should the ordinary long hames be permitted in an orchard.

Cultivation should be given after every heavy rain, or as often as once in two or three weeks, until about August 1st, when a cover crop of vetch or clover should be sown, using about 1½ bushels of the former or 15 pounds of the latter to each acre. The question of cropping the young orchard is discussed in another connection.

MULCH.

The effect of an old board or a log, or a stone wall, in encouraging the growth of grass or weeds along the roadside, is a familiar sight. The reason for this effect is that the moisture underneath this board, or stone wall, is unable to escape, except as it is pumped out by means of the roots of the plants. The grass in the open fields is stunted because of the excessive number of plants crowding one another in the struggle for existence, and the fact that there is nothing to hold moisture accumulated in the soil. The practice of mulching trees is based upon the principle here suggested.

There are certain cases where mulching is of unquestionable advantage; but there are also certain objections to the practice. Some of the best apple sections of the state include steep hillsides, where cultivation is entirely out of the question. In such cases a mulch of straw, meadow hay, weeds, or any coarse material, may be used to advantage. With young trees, too, a mulch of stable manure is often useful; but care should be used that the manure does not come in close contact with the bark of the tree, or serious injury will result.

To be of value, the mulch should be constantly maintained, that is, should be renewed as soon as the grass begins to come up through it; and should cover an area of several feet in diameter. In the case of newly set trees, a circle four feet in diameter will be ample. The diameter of the circle should be increased as the trees grow. The custom of piling manure several inches deep in a small circle about the base of a bearing tree, is both ridiculous and wasteful, as the feeding roots of the tree are at a considerable distance from the body.

The mulch about plants furnishes a harbor for injurious insects, field mice, etc. Injury from the latter, however, may be prevented by placing a cylinder of wire netting about the base of the tree. The wire should be somewhat larger than the tree, to allow for the expansion due to growth.

In case of fire, mulching greatly increases the risk of damage to the trees. but this danger is usually somewhat remote.

Another danger in the practice of mulching, on the lighter soils, is the tendency to encourage the development of surface roots, which are liable to suffer in time of drought unless the mulch is properly renewed.

SOD-MULCH.

The so-called sod-mulch, or the Hitching's method of growing orchard trees, is quite different from the system of mulching mentioned above. By this method the trees are planted in sod land and the soil is never afterwards disturbed. Such grass as grows upon this land is cut each year, and while the trees are young is placed as a mulch about their roots. Later the only attention given is to mow the grass twice during the season and leave it upon the ground as it falls. This method has the merit of economy of labor, and of being adapted to rough lands. It also results in highly colored fruit, but on most soils an addition of some form of plant food will be required. The particular fertilizer to use, and the amount per tree or per acre, will naturally be governed by local conditions. In most cases which have come under the writer's observation, in West Virginia, nitrogen and phosphoric acid, rather than potash, seem to be the elements required.

CROPS AND COVER CROPS

The question: "What crops may be grown in a young orchard?" is of frequent occurrence. In general terms the answer must be: Any hoed crop which will not interfere with the growth of the trees; hay or grain, never.

Of course there are qualifying factors entering into every problem. The soil, the aspect, the markets, the capability of the manager, insect and fungous enemies, the time of maturity of crop, all have an important bearing. Beans, potatoes (if care is taken that the rows are not too close to the trees), tomatoes, sweet corn, and in some sections sweet potatoes, may be safely planted. Oats, barley, wheat, hay, and in most cases tall field corn, should be avoided.

The reason for this distinction in the crops for an orchard is evident. Those of the first class permit of cultivation early in the season, mature in time so that cultivation may cease late in summer and that a winter cover crop may become established before the ground freezes; do not unduly shade the young trees. Those of the second class absorb the soil moisture, just when it is most needed for the growth of the trees, and, in the case of the field corn, actually shade the trees to an injurious extent.

Methods of culture of the various crops mentioned are so familiar as to require no special detailed account at this time. Because of its importance, however, and the possibility of fostering a new industry, as well as because of its special adaptation to the purpose of an orchard crop, particular attention is called to the tomato.

THE TOMATO AS AN ORCHARD CROP.

In many respects, particularly in the eastern part of the state where the conditions seem specially adapted to this crop, the tomato is one of the most promising crops for use in the young orchard. The period of culture is just about right for the trees; there is an active demand for the product at profitable prices; there is ample time for the establishment of a winter cover crop of rye after harvesting the fruit.

As indicating the importance of the tomato industry already under way, it may be said that in Morgan County, which is the leading tomato district, at present, there are now nineteen canneries; the largest of which, that of W. A. Rockwell, at Berkeley Springs, has a capacity of 1,000 bushels per day. On an average, each of these canneries will pack the product from 150 acres of land. The average yield is 150 bushels per acre, and the price paid 30 cents per bushel. In other words, by planting tomatoes in the young orchard, the farmer may reasonably expect a return of $45 per acre; which will pay all expenses of fertilization and cultivation of trees, and still leave more profit than would be obtained from a crop of grain without the trees.

It is unnecessary at this time to go into the details of the culture of tomatoes. Suffice it to say, the practice of the writer has usually been to sow the seed in greenhouse or hot bed not later than April 1st and preferably about March 15. Transplant to 3 or 4 inches apart as soon as the plants begin to crowd. While some of the best cultivators combat the idea that transplanting is of advantage in securing stocky plants, in our own experience the practice has always been found beneficial.

The notion often expressed, that the tomato is specially susceptible to a chill early in the spring, seems to be without foundation; the check at time of transplanting being more often due to poor soil and to improper handling, both at the time of transplanting and previously, than to "shock". In general, best results are obtained if the plants are removed to the field, which should first be thoroughly pulverized, as soon as the ground is well warmed and danger from frost is past.

The old notion that tomatoes do best in relatively poor soil, was long ago exploded.* Comparatively little work has been done, however, toward determining the specific elements which will produce the best results. Deductions from work conducted in Maryland** indicate that potash has a tendency to produce a relatively large per cent of acid in the fruit, while phosphoric acid seems to have a similar effect upon the sugar content. Voorhees *** has found that nitrate of soda, while increasing the yield, does not do so at the expense of earliness of maturity, if used in small quantities or in two or more applications; but if large quantities of nitrate were used in one application, maturity was retarded. Moreover, it was concluded that nitrogen is the ruling element in the growth of the tomato, though its effect is dependent upon the presence or absence of a full supply of the other elements.

In general, while heavy fertilizing does not lessen productiveness, the best fertilizers for tomatoes are those which act quickly, or hasten growth early in the season. This fact, together with the the cultural factor already mentioned, makes the tomato a specially good crop to use in the young orchard.

By this combination, two most important industries may be developed side by side; the one paying the expense of the other until such time as the orchard shall demand the whole time and attention of the grower.

COVER CROPS.

The importanee of a winter cover for orchard lands that are given clean culture during the summer, should in no case be overlooked. Some of the advantages following the use of such crops may be briefly summarized as follows:

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*Bailey and Munson, Bul. 21, Cornell Univ. Expt. Sta.

**Patterson, Bul. 11, Md. Expt. Sta.

***Voorhees, Bul. 63, N. J. Expt. Sta.

(1). The cover crop utilizes soluble fertilizers which would otherwise be wasted.

(2). Prevents washing of the land.

(3). Adds organic matter to the soil.

(4). Protects roots during the winter and holds the snow.

(5). Helps to dry out the soil in the spring, thus permitting earlier working of the land.

(6). In some cases adds directly to the store of nitrogen in the soil, as when vetches, clover and other leguminous crops are used.

(7). Checks growth of trees late in autumn, thus preventing winter injury by cold.

KIND OF COVER CROP.

What to sow for a cover crop, depends largely upon soil and location. On good strong land, which is not specially in need of additional nitrogen, winter rye is very satisfactory. It germinates quickly and, even in cold seasons, when frosts come early, will form a very satisfactory mat before winter. On "thin" soils, however, rye does not stool freely, and fails to make a good cover. Such soils are usually in need of more nitrogen, and will be benefitted by the use of some leguminous crop like vetches or clover.

One of the best cover crops for the lighter soils is winter vetch (*Vicia villosa*), sown at the rate of 1½ bushels per acre, as early as July 15. Within six weeks this plant develops nitrogen accumulating nodules, and contributes directly to the fertility of the land. The price of seed of this vetch is so high, however, as to be almost prohibitive.

Spring vetch (*Vicia sativa*) is another nitrogen gathering cover crop which makes a vigorous growth in the fall, often forming a perfect mat a foot thick, when sown August 1. It is apparently even more efficient than the winter vetch as a nitrogen gatherer, but it does not survive the winter; hence is not

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as valuable in preventing washing by the spring rains, and does not help dry out the land in spring.

Clover, sown July 15 to August 1, makes a satisfactory cover for winter, and is one of the best nitrogen gatherers and soil renovators.

Oats, peas, and these two crops combined, are sometimes used to advantage. All things considered, however, the three first mentioned are most satisfactory.

A WORD OF CAUTION.

While in general the use of a cover crop in cultivated orchards is advantageous, there are cases where, if used injudiciously, it may be actually detrimental. One such case is the use of rye upon a soil naturally dry and gravelly; especially if the crop be left late in the spring before plowing under. This treatment may result in so drying the soil as to seriously interfere with the growth of the trees. On soils of the nature indicated, one of the vetches, oats, or clover is to be preferred; particularly if the land is not to be plowed promptly in the spring.

SUGGESTIONS AS TO PRUNING.

Intelligent pruning, at the right time, is absolutely essential to the production of the best fruit. An unpruned tree may, in many instances, produce a larger number of apples than an adjacent pruned tree; but the percentage of merchantable fruit will invariably be smaller. Small apples or peaches contain just as many seeds as do large ones, and therefore make practically as great demands upon the store of plant food. They do not, however, fill the basket, nor the pocketbook, so rapidly as the others.

METHOD OF PRUNING

The amount of pruning necessary depends largely upon the location and exposure of the orchard. Trees on a warm southern slope, freely exposed to the winds, require much less pruning than do those in a cool sheltered location which is lacking in sunshine. Plenty of light is essential to the production of highly colored fruit. It is desirable that trees should be pruned intelligently from the time they are set, but old trees may often be given a new lease of life by judicious management. If the trees have been long neglected and require heavy pruning, do not remove all of the wood the first year. Removal of a portion of the top, thus distributing the food gathered by the roots to a smaller number of branches, tends to produce rapid growth and renewed vigor of the tree. The removal of too much at one time will start the growth of water-sprouts and defeat the very purpose in view.

The method of shaping the top of young trees will depend upon the natural habit of the variety, the ideal of the grower, and the local conditions. No attempt should be made to make all varieties conform to a given type, like trees in a hedge. In general, limbs which are parallel and close together, or limbs which cross and interfere with each other, should be removed or thinned. Trees of an upright habit, like Sutton or Maiden Blush, should have the center of the top opened, while trees of a spreading habit, like Jonathan or Rhode Island Greening, should have the lower limbs removed. To keep the trees within bounds, the leading branches may be cut back one to three feet about every other year until the bearing age is reached; after which the production of fruit should sufficiently check superfluous growth of wood.

The question of high heads or of low heads is a perennial one. In general, however, the tendency at the present time is to maintain as low heads as is consistent with cultivation. The ideal tree is vase-formed, the lower branches starting about 2½ feet from the ground, and ascending in such a manner as to permit of reasonably close approach to the tree in cultivating. This may be accomplished by cutting off those limbs which tend to grow out horizontally or which hang from the lower side of the leaders.

WHEN TO PRUNE

The best time for pruning is on warm days from January to May. More can be accomplished in the longer days of April and May, but if there are many trees to be pruned, the work should be commenced earlier in the season. The time of year when the cut is made has little effect upon the readiness with which the wound heals, but more care is necessary to prevent injury to trees pruned when the wood is frozen.

A wound made by removing a limb heals best if the cut is made close to the trunk or branch. A stub two or three inches long does not heal, and becomes a lodging place for spores of fungi and bacteria which cause decay and death of the tree. The splitting down of large limbs may often be avoided when pruning by sawing in from the under side first; but, in every case, see that the wound is left clean and smooth. Wounds should also be covered immediately with a coat of paint, shellac or grafting wax, to keep out the moisture and spores before mentioned. Nothing is better for this purpose than pure white lead and linseed oil.

The whole philosophy of the pruning of plants rests upon the fact that the various parts are unlike; that each branch is, in a measure, independent and capable of becoming a new individual; that by lessening the conflict between the parts, the growth of the whole is promoted. Pruning is a necessity, and the pruning given by Nature, in a neglected orchard or forest, is more severe than the average man would dare to attempt.

It is often urged that pruning should be commenced when the tree is planted, and continued annually throughout the life of the tree. It is doubtful, however, whether equally good results may not be obtained by removing superfluous branches at four or five years of age, rather than by severe pruning very early in the life time of the tree. In other words, it is contended by some that it is better to permit the root system to become thoroughly established before disturbing the top. This question is under consideration at the Experiment Station at the present time.

WHY PRUNING IS IMPORTANT

It is astonishing to find how little the average orchardist thinks, when pruning his trees, of the actual problems at issue. Pruned trees are almost always more vigorous than unpruned ones, because the food taken up by the roots is concentrated into a smaller number of branches.

Pruning is practiced to produce larger and better fruit; to keep the plant within manageable limits; to remove superfluous or injurious parts; to facilitate spraying, tillage and harvesting; to train the plant to some desired form.

Plants naturally grow from the uppermost buds. By pruning in one way this tendency is augmented, in another way it is checked. As a rule, in dealing with fruit trees, the latter end is desired, since the principle that "checking growth induces fruitfulness" is universally recognized. The heading in of young growths tends to develop lateral and dormant buds, or to thicken the top; so the question of heading resolves itself into a question of personal ideals. To secure thick topped trees, heading is necessary. It has, however, the very marked advantage of inducing the development of fruit buds near the body of the tree, rather than far out on the limbs. This, in the case of plums and other tender wooded plants, is an important consideration.

Fruit bearing is determined more by the habit and the condition of the tree, than by the extent of pruning. In other words, it is to a certain extent an individual characteristic. Pruning, however, may be made a means of thinning the fruit, and thus improving the size and quality of that which remains by removing superfluous shoots upon which fruit buds are borne. Heading back the annual growth thins peaches; but with the apple, pear and plum, which produce fruit on spurs or miniature branches, on wood of more than one season's growth, older limbs must, of course, be removed in order to effect the desired thinning.

CONTROL OF ORCHARD PESTS.

The importance of watchfulness, and the direct value of spraying, as a means of holding in check insect and fungous enemies of the orchard, have been repeatedly urged by this Experiment Station, and in so far as the suggestions made have been followed, the results obtained by the fruit growers of the state have been satisfactory.

SPRAYING IS PLANT INSURANCE

Spraying is a form of insurance, and should in most cases be applied before the plants are attacked, as a preventive measure, rather than as a remedy. It has been shown beyond doubt that, by spraying at the proper time, and in the proper manner, the canker worm and tent caterpillar may be held in check; that the "apple worm" or codling moth may be controlled; that scale insects may be destroyed; that the green aphis or plant louse may be killed; that bitter rot, apple scab, cracking of pears, and rotting of plums may be very greatly reduced in this simple way. This being the case, spraying, in an intelligent and thorough manner, should be just as much a part of the regular work of fruit growing as is cultivating, pruning, or even harvesting. As a rule it is impossible to get the best fruit without spraying, and at the present day only the best fruit is profitable. During the past year thousands of barrels of apples were put upon the market in this state, which were hardly fit to feed the hogs—all for the want of intelligent spraying.

REASON FOR SPRAYING.

The leaves of plants have two functions essential to life and health. They act, in a measure, as both lungs and stomach for the plant. Consequently if they are destroyed or diseased, the whole plant suffers; the crop of fruit is lessened; and the vitality of the plant is weakened. It is for this reason that spraying is of importance, even in those seasons when there is no fruit. As before suggested, spraying is an insurance, not a remedy, and there should be a definite purpose in view for every application. Specific directions for controlling the leading insect and fungous enemies of the orchard are given in Bulletins 66 and 107, and in Special Bulletin 4.

PRACTICAL SUGGESTIONS.

Cleanliness is one of the first considerations in fighting orchard pests, whether of animal, insect or fungous nature. So every effort used in raking up and burning diseased leaves, and in picking and destroying dried and decaying fruits in the fall, is labor well expended.

It is now too late to spray with the lime-sulphur mixture this season, but in general the application of this mixture late in the fall, or early in spring, before the buds begin to swell, and before the land is too soft to prevent driving over it, is of marked importance in controlling both scale and fungous enemies. If the lime-sulphur spray has been used this season, no other spraying is required until just before the blossoming period, when Bordeaux mixture and arsenate of lead* should be applied.

Another application of Bordeaux mixture (3-5-50 formula) and arsenate of lead should be made soon after the blossoms fall, and again 2 or 3 weeks later, as an insurance against codling moth, also against apple scab and other fungous enemies.

In August and September, if Bitter Rot makes its appearance, all diseased fruits should be carefully picked and destroyed as fast as they appear, and the trees should be sprayed every 10 days or 2 weeks with Bordeaux mixture. The gathering and destroying of infected fruits are of special importance, and in no case should be overlooked. In large orchards it will pay to have one or more men whose whole time should be given to this one work of gathering and burning diseased fruit.

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* For formulas see Special Bulletin 4 of this Station.

While further experiments are necessary in the control of the so-called "frog-eye" fungus, it is probable that much benefit will result from the treatment suggested.

Another serious pest, in some sections of the state, is the woolly aphis. Young trees with the characteristic root galls should not be planted. A liberal application of tobacco dust to older trees which are thus affected may sometimes be useful.

Twig blight often appears to a destructive extent upon young thrifty apple and pear orchards. This is a bacterial disease, and no amount of spraying will be of service. Cut and burn all affected parts, and avoid highly nitrogenous fertilizers.

Canker is another serious pest. Carefully cut out and burn all canker spots, and paint the wounds with pure white lead and linseed oil. The same may be said for black Knot of plum and cherry.

ENEMIES OF YOUNG FRUIT TREES.

W. E. Rumsey and Fred E. Brooks.

This paper deals with several kinds of insects and mammals that injure young fruit trees before they have reached a bearing age.

The treatment which an orchard tree receives during the first few years of its growth often determines to a considerable degree the profitableness of its bearing life. If allowed to become weak and stunted, as a result of the attacks of borers and other insects, it may live on from year to year, but will probably never fully recover. Many young trees are killed outright by such pests, or are so seriously injured that they soon succumb to droughts or are broken down by storms.

A young orchard that is not protected from these enemies is likely soon to show many missing trees, and those remaining will be irregular in size and will lack uniformity in shape, vigor and productiveness. If the neglect is continued, these defects will become more and more apparent as the orchard advances in age. It is essential, therefore, in establishing a good orchard, that the trees not only come from the nursery free from hurtful insects and insect injuries, but that they be kept so.

Young trees are less able to withstand severe injuries than are old ones, but they are, likewise, more easily protected. Their small size makes it an easy matter to examine them for, and to remove, borers. They can be sprayed quickly and effectively, and such insects as tent-caterpillars and web-worms can be removed from their branches by hand with but very little trouble or expense. It is possible, too, with very little cost and labor, to protect their bodies from the ravages of mice and rabbits, and from the adult borers during the egg-laying season.

In this article a few of the more important enemies of such trees are described. For convenience the different species are divided, according to their methods of attack, into six groups, as

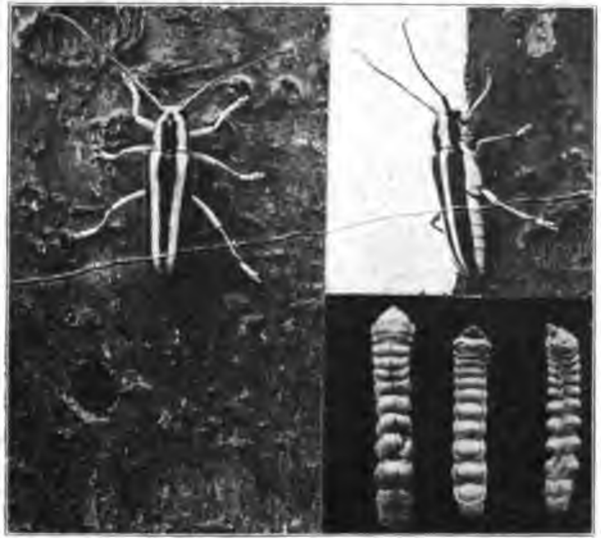

Figure 3. Round-headed Apple-tree Borer. Larvae, adults and exit hole. (All natural size).

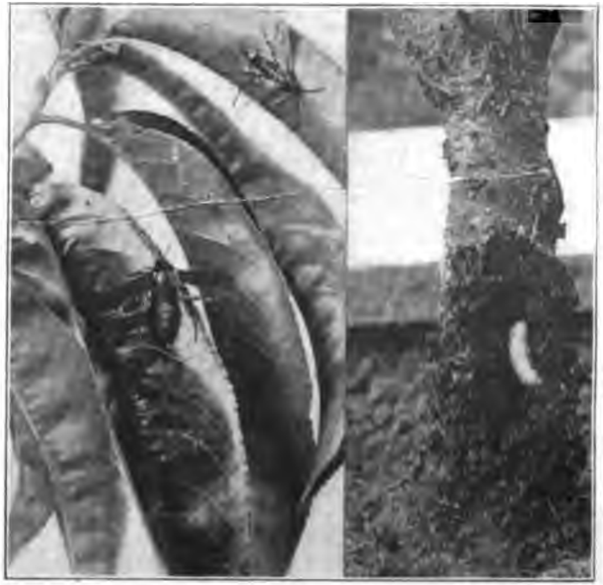

Figure 4. Peach-tree Borer. Larva and adults.

follows:—Borers, leaf-eating caterpillars, scale insects, cicadas, plant-lice and mammals.

Only such species as are known to be common in West Virginia are considered. For directions for preparing the different sprays that are recommended, see Special Bulletin 4, of this Station.

BORERS.

THE ROUND-HEADED APPLE-TREE BORER, *Saperda candida* Fab. (Figure 3).—The adult of this destructive insect is a handsome, elongate beetle which flies by night and secretes itself by day. Specimens in our collection range in length from five-eighths to seven-eighths of an inch. The color of the back is a soft shade of brown with two silvery-white stripes extending the full length of the insect on either side of the middle of the back. The underparts are white; the antennae long and conspicuously jointed.

The beetles appear in June and July, and deposit their eggs on the trunks of trees near the ground. The young borers hatch from the eggs in two or three weeks, and begin at once to eat their way through the bark. The first year is spent by them in burrowing about through the sapwood. The second year they penetrate the heart-wood, and in young trees will often almost sever the trees near the surface of the ground. The third year they transform to beetles and deposit eggs for another brood of borers.

This species is especially troublesome to apple and quince, and somewhat less so to pear. It also breeds in crab apple, thorn and other nearly related trees. In feeding the borer throws out sawdust-like chips, by which its presence may usually be detected.

If trees are examined carefully every fall and spring, the borers may be found and removed with a sharp-pointed knife while they are yet feeding in the sap-wood. If, however, the trees are neglected for a single year the borers will work their way into the interior of the body and can not be removed without danger of seriously adding to the injury already done.

The attacks of this borer may be prevented quite effectively by covering the lower portion of the trunk with wire mosquito-netting. At least two feet of the trunk should be covered and the netting tied close to the bark at the top and hilled with earth at the bottom. Such a screen will shut the adult female borers away from their favorite point for depositing their eggs. Wrappers of heavy paper may be made to answer the same purpose.

THE FLAT-HEADED APPLE-TREE BORER, *Chrysobothris femorata* Fab.—This insect attacks a great variety of fruit and forest trees. The adult is a beetle, but in appearance it is very unlike the round-headed borer, just described. It resembles more closely some of the "snapping-bugs" or "click-beetles." Different individuals vary greatly in size, the average length being about half an inch. The color of the back is dark, metalic-bronze blotched with gray. The underparts are burnished copper and the antennae green.

The insect flies by day in midsummer and glues its eggs to the bark, preferably of young trees that are diseased, or about wounds or sunscald spots. The eggs may be laid at any point on the body or larger limbs. The larvae, or borers, are light yellow in color, and when full grown are nearly twice as long as the mature insect. The segments at the head end are greatly enlarged and flattened, hence their common names of "flat-heads" and "hammer-heads."

The borers work just beneath the bark, where they excavate broad channels which are left partly filled with powdery excrement. When nearly full grown they eat deeper into the wood, but return again to the bark to pupate. This species is said to remain in the pupal state about three weeks. On reaching maturity the beetle cuts its way out, leaving an elliptical exit hole in the bark.

The remedies advised for the round-headed borer may also be used against this species. When the borers are once at work in the tree the only remedy that can be employed with satisfactory results is the process known as "worming," which consists of cutting the borers out with a knife. Washes made of home-made or fish-oil soaps and applied to the trees during June and July will, to some extent, prevent the females from depositing their eggs on the bark.

THE PEACH-TREE BORER, *Sanninoidea exitiosa* Say. (Figure 4).—The adult of this well-known pest of peach and plum trees is a wasp-like moth which flies by day, being wholly unlike either of the preceding species. The male is about five-eights of an inch in length. The wings are transparent and bordered with blue, which is the general color of the body. The female is larger and the hind-wings only are transparent. The fore-wings and body are of a more lustrous shade of blue than in the male and a broad band of orange yellow encircles the abdomen at the middle. The flight of moths is so rapid that they seldom attract notice.

During the summer of 1907 the moths were flying in Upshur county from the middle of June to as late, at least, as the first of September, the bulk of them appearing during the last half of July and August.

The eggs are deposited on the bark, usually near the ground. The larvae feed only on the bark of the lower part of the trunk and the roots. The wounds which they make in feeding are marked by gummy exudations, with which is mixed the reddish-brown frass of the borers.

After a period of about ten months of feeding, the borers leave the roots and, near the surface of the ground, construct cocoons, which are composed chiefly of grains of excrement held together with gum and threads of silk. Within these cocoons in a short time they transform to moths.

From observations made last year, we have reason to believe that occasionally a borer which hatches very late in the season will remain in the tree over two winters. The greater part of them, however, change to moths in about a year from the time the egg is laid.

The most satisfactory way of dealing with this insect is the cutting out process. The work should be done in the fall, to secure the young borers, and should be repeated in the spring, with equal thoroughness, to make sure of any that might have been overlooked in the first "worming." The tools needed for this work are a gardener's trowel for removing earth, a stiff wire for prodding into cracks between roots where borers are lodged, and a sharp, long-bladed knife for cutting away the bark.

If trees are mounded with earth about the first of June, the eggs will be laid and the borers will enter higher up on the trunk. This will greatly facilitate the work of "worming."

Protecting the bodies of the trees with mechanical devices and washes can be resorted to with partial success. Such measures, however, should always be accompanied by the use of the knife to secure the few borers that are almost sure to gain entrance to the trees in spite of precautions.

THE FRUIT-TREE BARK-BEETLE, *Scolytus rugulosus* Ratz.—This is a small beetle, about one-tenth of an inch long, of a uniform black color, except the tips of the wing-covers and parts of the legs, which are reddish. It attacks apple, pear, plum, peach, cherry, quince and other fruit trees. Its presence is indicated by minute circular holes in the bark, the holes being about one-sixteenth of an inch in diameter. In the early part of the growing season these holes will more often be found at the base of the buds in young orchard trees, but later they will be scattered promiscuously over the trunk and branches.

In the spring the females make longitudinal burrows, from an inch to an inch and a half in length, between the bark and the sap-wood. Along the sides of these burrows minute chambers are cut and an egg placed in each. In three or four days these eggs hatch, and the larvae mine about beneath the bark for about twenty days, when they construct cases in the outer sap-wood in which they transform to pupae. This dormant stage lasts for about a week, when the beetles appear and mine out through the bark. In badly infested trees the inner bark is converted into powder, and after a brood emerges the outer bark is filled with small holes as though bird shot had been fired into the tree.

It is usually conceded that this insect prefers to attack trees that have become weakened by other insects or by disease. The advent of the San Jose scale seems to have greatly favored the work of this pest, for when trees become weakened by the scale the beetles find in them congenial breeding places and hasten their death. Trees weakened by over-bearing, or injured by untimely freezes, are likewise sought by the beetles for breeding places.

The other borers mentioned here can be controlled by "worming" the trees, but the process is wholly impracticable with this species, owing to its small size, great abundance, and its habit of attacking all parts of the tree. About all that can be done in the way of preventing injury is to keep the trees in a vigorous condition. Whenever a weak tree is attacked by this pest, it should be cut and burned at once. Prunings or dead trees should never be left lying about the orchard. Such wood is almost sure to be utilized by the beetles for breeding places.

There are several parasitic and predacious insects that help to check the multiplication of this pest, but they cannot be relied upon to prevent damage without the assistance of the orchardist, especially when local conditions favor the spread of the beetles.

LEAF-EATING CATERPILLARS.

THE APPLE-TREE TENT-CATERPILLAR, *Malacosoma americana*, Fab.—During the spring and early summer, the white tents of this insect are conspicuous features of the landscape in some parts of this state. The tents are especially numerous in wild cherry and apple trees, but are liable to be seen on almost any kind of cultivated or forest tree.

The moth which is responsible for the caterpillars that construct these tents is a robust, night-flying species, with a wing expanse of from one to two inches. The color is a dull reddish-brown, with two parallel white lines extending obliquely across the forewings of both sexes. The moths appear in June and lay their eggs by night in thimble-like masses near the ends of small twigs. The eggs remain on the trees over winter, and hatch as soon as warm weather comes in the spring. The caterpillars begin at once to feed on the young leaves, constructing meanwhile a tent of silken web in some convenient crotch of a limb in which they rest when not feeding. In about six weeks the caterpillars become full-grown and wander away from the nest. In a few days they find some sheltered corner or crack, where they spin their cocoons and pupate. The cocoon is about an inch long, oval in shape, and is composed outwardly of whitish threads of silk through which is mixed a little sulphur-colored powder. About three weeks later the moths emerge from the cocoons and the life-cycle is thus complete in a year from the time it began.

The egg masses on the twigs are covered with a frothy, glistening substance, which makes them somewhat conspicuous when the trees are bare of foliage. This renders it an easy matter to collect them from young trees in the winter and spring. Every egg mass destroyed in this way means one less tent in the spring. The tents may be torn out with a stick and the caterpillars destroyed. The caterpillars succumb readily to sprays of Paris green or arsenate of lead.

In dealing with this insect it is a good plan to remove all useless wild-cherry trees that may be growing in the vicinity of the orchard, as they serve as breeding places for the moths.

THE FALL WEBWORM, *Hyphantria cunea* Drury. (Figure 5). The caterpillars of this species, like the ones just described, construct tents and feed gregariously. The tent is large, and loosely woven, and the caterpillars feed only on leaves that are enclosed in the web. When the supply of leaves within is exhausted, the web is enlarged to take in more and, in this way, the entire top of a young tree may be webbed over and defoliated.

The form of the tent and the manner of feeding of the worms will enable the orchardist to distinguish this species from the tent-caterpillar.

The eggs are laid in masses on leaves, and the larvæ begin feeding as soon as they are hatched. These larvæ, or caterpillars

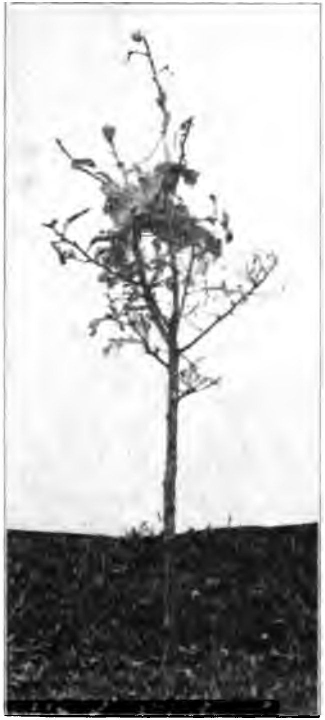

Figure 5. Nest of Fall Web-worm on young pear-tree.

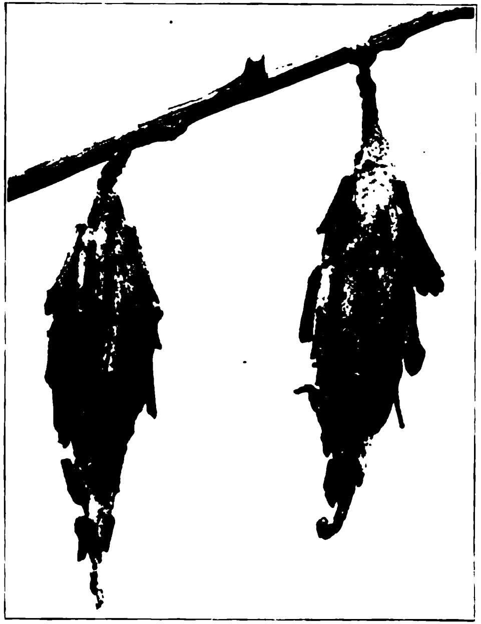

Figure 6. Bag-worm cases. (Natural size).

are covered with long, yellowish hairs. They grow rapidly, and when ready to pupate seek some sheltered place and construct fragile cocoons of web and hairs. The moths are nocturnal in their habits. They vary considerably in color, some being pure white and others white with black spots on their wings.

Two broods of the caterpillars appear in a single season; one in the spring and the other in the fall. The fall brood is usually much more numerous and destructive. The caterpillars attack a great variety of trees and shrubs, but seem to be especially fond of the leaves of apple, pear and quince.

In some sections of this state there is a midsummer brood which feeds almost exclusively on the leaves of the "sour-gum" or "sorrel-tree," *Oxydendrum arboreum.* This seasonal form produces but one generation of caterpillars annually.

Webworms, as well as tent-caterpillars, are likely to be excessively abundant for a period of a few years and then become so reduced in numbers, by parasites and other natural enemies, that for a corresponding period they will scarcely be seen. The decrease of the caterpillars, however, causes a famine among the parasites, and they in turn die off, when the caterpillars at once begin another period of increase.

The webworms may be destroyed by burning or tearing out their tents, or by the use of the same sprays suggested for the tent-caterpillars.

THE FALL CANKER-WORM, *Anisopteryx pometaria* Harr.—This is a northern insect that is found in West Virginia only in restricted districts. We have records of its occurrence in Hampshire, Hancock and Morgan counties. In some parts of these counties it has been very destructive for several years.

The adult is a small, gray moth, the females of which are wingless. Eggs are deposited on the bark of the branches, and the larvæ, which are "span-worms" or "measuring-worms," hatch in the spring at about the time apple-trees are putting forth their first leaves. The worms scatter over the trees and feed ravenously on the leaves. When they are numerous, orchard and forest trees will sometimes be almost defoliated over considerable areas of country.

Spraying the trees when the worms first appear, with a stomach-poison, preferably arsenate of lead, is the best remedy.

THE YELLOW-NECKED CATERPILLAR, *Datana ministra* Drury. —It frequently happens that in September, or early October, the owner of a young apple orchard will find here and there a tree that has been entirely denuded of foliage by some insect which has eaten the leaves and then disappeared. Often the pellets of excrement scattered thickly over the ground under the injured trees will furnish the only clue for determining what species has committed the offense. There are several kinds of caterpillars that attack young apple-trees in this fashion, one of the more common of which is named above.

These yellow-necked caterpillars hatch from eggs laid on the leaves by a good-sized moth, of a brownish-yellow color. The caterpillars feed in companies and grow rapidly. Very often they will not leave a scrap of green leaf upon the tree. When full-grown they descend and enter the ground to transform, in due time, to moths.

The caterpillars attain a length of nearly two inches. The head is black, the neck yellow and the rest of the body is yellow and black spotted.

This species can very readily be destroyed by hand or by spraying with one of the arsenates.

THE RED-HUMPED PROMINENT, *Oedemasia concinna*, S. & A. —The manner of feeding of this species is very similar to that of the one just described. The caterpillars are of a yellowish-brown color, with black lines extending along the sides. The head is red and the fourth segment of the body is prominently humped and of the same color as the head.

Remedies, same as for the yellow-necked caterpillar.

THE BAGWORM, *Thyridopteryx ephemeraeformis* Haw. (Figure 6).—This peculiar insect has caused some alarm in certain sections of the state during recent years. They have appeared in great numbers on apple and other fruit trees, and a fear has been felt that they might prove to be a serious orchard pest. It is a native species, however, whose habits are well known,, and, judging from the past, it is not likely to do serious damage to any trees except evergreens.

The life-history of the species is about as follows. It winters in the egg stage in the old female bag. In spring the young hatches and begins at once to feed on the nearest leaf, constructing meanwhile a case to cover its own body. The case is composed of web and bits of stick and is carried by the caterpillar wherever it goes. As the caterpillar grows the case, or bag, is enlarged, and when growth is completed it attaches the bag to a twig by a strong, silken band and changes within to a pupa. In about three weeks the male emerges as a dark-colored moth with transparent wings. The female never develops wings but remains as a grub-like object in the bag, where she is fertilized by the male. The eggs are laid in the bag, and then the female drops out and dies.

The favorite food of the bagworm is arbor-vitae and other evergreens. The caterpillars multiply on such trees and become exceedingly abundant, when they often extend their ravages to fruit and other deciduous trees.

The bags hanging to the branches are conspicuous objects during the winter months, and one of the best ways of ridding trees of this insect is to collect and destroy the bags while the trees are bare. Spraying infested trees in the summer with Paris green or arsenate of lead is also an effective remedy.

CICADAS.

THE PERIODICAL CICADA, OR SEVENTEEN-YEAR LOCUST, *Tibicen septendecim L.*—This insect sometimes does serious damage to young fruit trees. For full description see Bulletin 68 of this station.

Plant Lice.

Insects of this class do considerable damage to young fruit trees. Especially is this true of the species known as the woolly aphis of the apple, which is described in detail later on. Most of the species that attack fruit trees are some shade of green in color and attack only the tender, growing twigs and foliage.

The life-history of the plant lice is similar in the different species. The winter is passed in the egg stage. These hatch, in the spring, agamic females which give birth to living young without the intervention of a male. These young, like the parent brood, are all females, and they in turn give birth to the same kind, and so on through the summer, until many generations have been produced. In the fall perfect males and females appear and pair, after which the females lay eggs and die. The eggs thus produced carry the species over winter. The small, black, shining objects which are frequently found on the terminal branches and water-sprouts of fruit trees are the aphis eggs referred to.

The eggs hatch in the spring at about the time the leaf-buds are opening, and the young lice suck nourishment from the tender growing parts. On badly infested trees the leaves curl and the growth is checked.

Sometimes in nurseries and young orchards these lice become so numerous that treatment is necessary to prevent serious injury to the trees. Kerosene emulsion and tobacco tea are the materials recommended for use in such cases. These may be applied as a spray or by dipping the infested parts in a vessel of the liquid carried from tree to tree. The latter method will prove most effective for the reason that the curled condition of the leaves makes it difficult to reach the lice with a spray.

THE WOOLLY APHIS OF THE APPLE, *Schizoneura lanigera* Haus. (Figure 7).—This familiar louse confines its attacks almost exclusively to the apple. Its presence on trunk or branch is very noticeable, owing to the white, woolly matter which is ex-

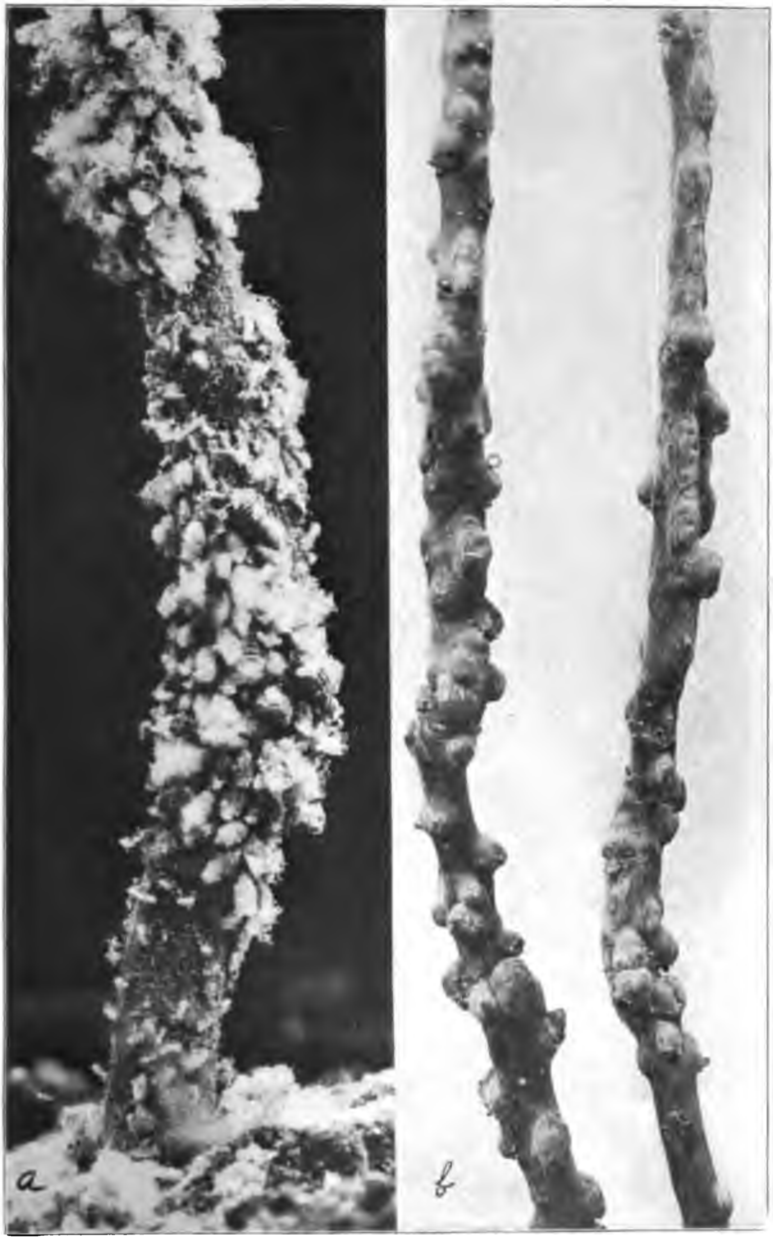

Figure 7. **The Woolly Aphis of the Apple.** ***a*, Insects on stem of seedling tree.** **(Magnified three times).** ***b*, Knots on twigs caused by the aphis.** **(Natural size).**

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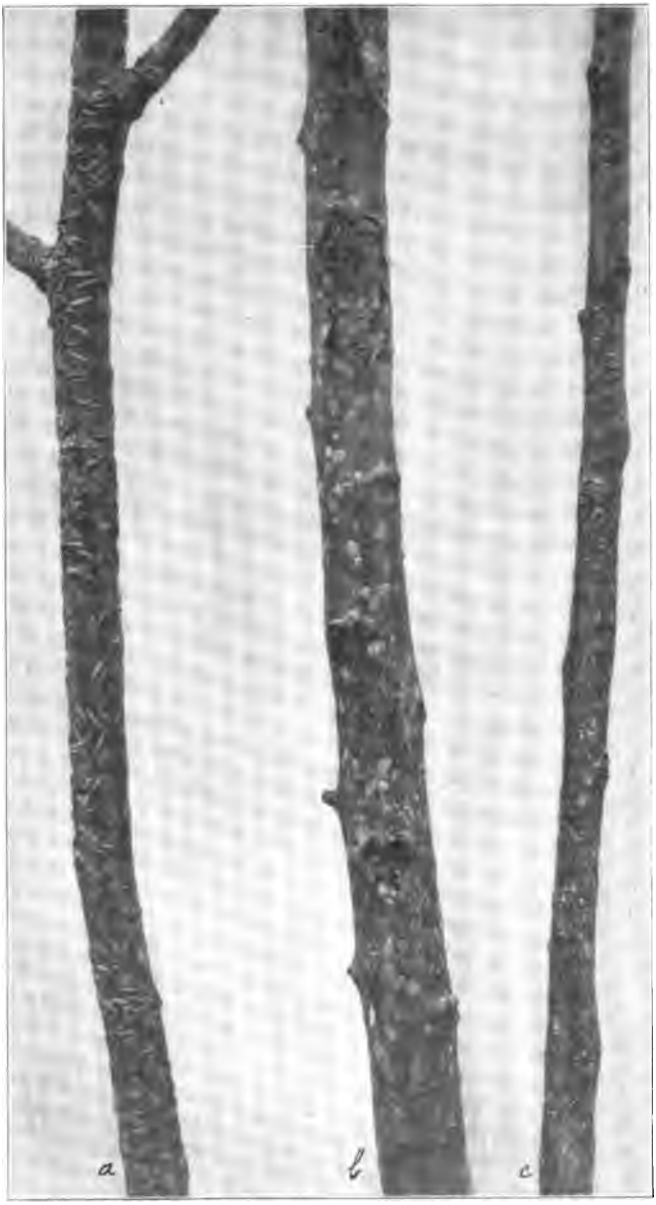

Figure 8. Three common scale insects. *a*, Oyster-shell Scale; *b*, Scurfy Scale; *c*, San Jose Scale. All natural size.

creted from the body. One not familiar with this insect might think that these fluffy masses were nothing more than flakes of wool or cotton that had accidentally lodged on the tree. An examination, however, would show that under these masses colonies of small, pinkish-colored lice were located, having their beaks inserted in the bark.

There are two forms of this insect, aerial and subterranean. Representatives of the former are usually found where there is a wounded or rough place on the body or limb; those of the latter attack the roots and are the ones that do the most damage. They are especially injurious to nursery stock and to young orchard trees. The root form secrets but little of the woolly matter mentioned above. Both forms cause wart-like growths at the point of attack, which disfigure and seriously injure the trees. Roots are sometimes found that are covered with these knotty excrescences. It is not unusual for such trees to die as a result of the injury. Others do not die, but become so impaired in vitality that they remain stunted and unprofitable. In planting young orchards all trees having badly knotted roots should be destroyed. Trees but slightly knotted should be root-pruned and dipped in lime-sulphur wash, or one of the soluble oils, mixed as for spraying. When the lice become established in a young orchard, the soil about the roots of the trees may be removed and tobacco dust applied to the roots with good results. Kerosene emulsion, of a 15% strength, may be used instead of the tobacco dust.

The aerial form may very readily be destroyed by spraying with kerosene emulsion, of the strength just mentioned. It is necessary, however, to apply the spray with considerable force so as to penetrate the woolly covering.

SCALE INSECTS.

SAN JOSE SCALE, *Aspidiotus perniciosus* Comstock. (Figure 6, *c.*)—This insect continues to be a most dangerous foe to fruit trees.

For description and methods of control, see Bulletin 107 and Special Bulletins 3 and 4, of this station.

THE SCURFY SCALE, *Chionaspis furfurus* Fitch. (Figure 8, *b*). This common scale insect infests apple and pear, and is quite often mistaken for the San Jose scale. It differs from the latter, however, in being more elongate in shape, of a lighter color, less destructive to plants, and in several details of life-history.

It is a common thing to find small, whitish spots, a little larger than a common pin-head, on the bark of young apple and pear trees. These spots resemble diminutive pumpkin seeds and are often very abundant, especially on water-sprouts that grow up from the roots of old trees. The spots are the stationary, scale-like coverings that protect the insect, or the eggs, of the species under consideration. If one of these scales is lifted with the point of a knife-blade at any time when the trees are dormant, it will be found to cover a batch of tiny, red eggs, which, if pressed with the point of the blade, will crush with a grating sound.

With the coming of warm weather the eggs hatch and the young insect, which is of the same color as the eggs, crawls forth to find a suitable place on the bark where it may insert its beak and settle down to draw nourishment from the tree. When feeding begins the whitish scale, referred to above, soon forms and serves as a protection to the insect.

When trees become so badly infested that treatment is necessary, the lime-sulphur and soluble oil sprays described in Special Bulletin 4 will be found effective.

OYSTER-SHELL SCALE, *Lepidosaphes ulmi* Linn. (Figure 8, *a*). This native scale insect is named from its resemblance in shape to an oyster-shell. Its life-history is similar to that of the scurfy-scale. There is but one brood annually and the winter is passed as an egg. It does not spread from tree to tree very rapidly, and the damage which it does is slight as compared with that of some other insects. Where it becomes established on a tree, however, it will sometimes multiply until the bark of trunk and branches will be entirely covered, giving the tree a very peculiar appearance and really

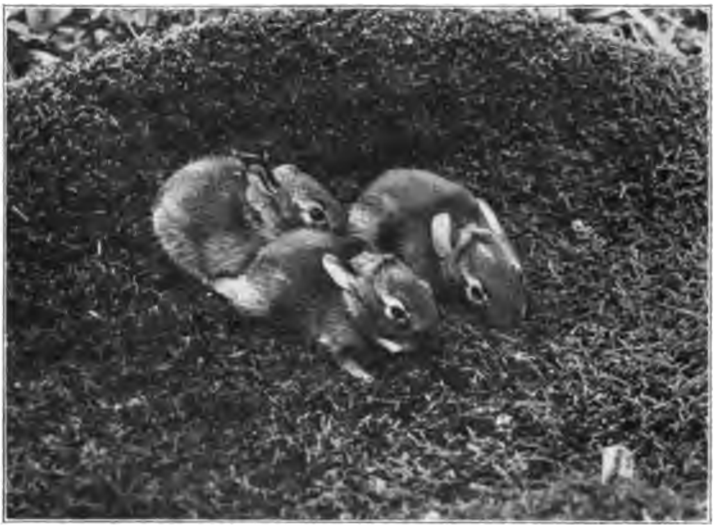

Figure 9. Young Gray Rabbits.

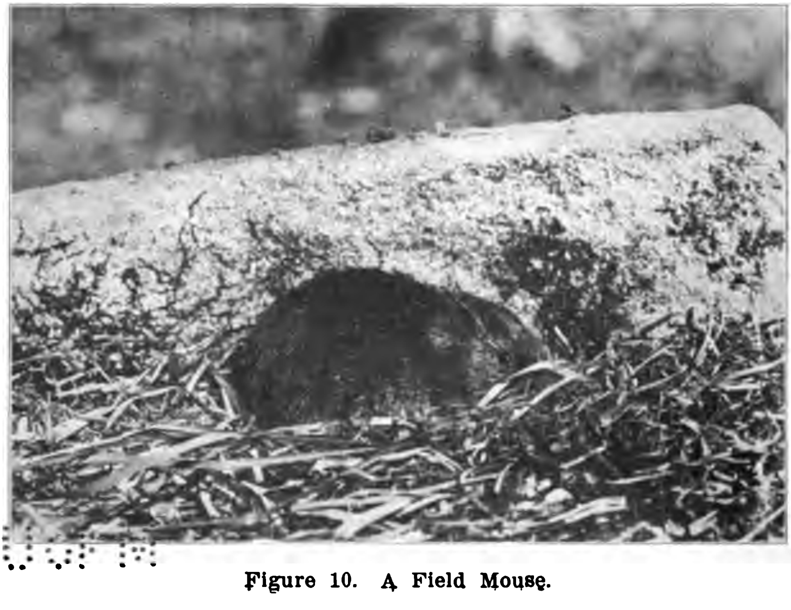

Figure 10. A Field Mouse.

injuring it greatly, or even killing it. It is more abundant in the higher altitudes of the state. The remedy is the same as for the scurfy-scale.

MAMMALS.

COMMON COTTONTAIL RABBIT, *Lepus floridanus malurus* Thomas. (Figure 9).—The common, gray rabbit frequently plays havoc with young orchard trees by girdling the bodies near the ground. The damage is usually done in the winter or early spring when the supply of other foods is scanty.

Trees may be effectively protected with wrappers of heavy paper or with repellant washes. There are several kinds of tree protectors on the market that give good results when used against rabbits. Perhaps nothing is better than the wood-veneer wrappers that are frequently advertised in the horticultural papers.

FIELD MICE (Figure 10).—For descriptions and methods of control, see Bulletin 113 of this station.

POULTRY IN THE ORCHARD.

HORACE ATWOOD.

Fruit culture and the production of poultry products can frequently be combined in a satisfactory manner. This is especially important during the first few years, before the orchard has come into bearing, and when any addition to the income is welcome.

There are several reasons why fruit and poultry can be produced economically together. In the first place fowls are very destructive to insect life, and if sufficiently large numbers are kept, few of the larger insects, which may spend a portion of their time on the ground among the dead leaves and grass, will escape. This destruction of insects tends, of course, to make the trees more healthy and the fruit produced more perfect.

The amount of fertility, too, which may be added to the soil through the droppings of the fowls, is a matter of no small importance, when considered for a series of years. Medium sized fowls, like the Leghorns, require about a bushel of grain per year, and larger fowls considerably more. The greater part of the nitrogen, potash, and phosphoric acid present in this grain passes into the excrement, and when this is scattered uniformly over the surface the soil should become more fertile from year to year, thus making the trees more thrifty, vigorous and productive. In these ways, then, will the fowls benefit the trees, while on the other hand the shade furnished by the orchard on the sultry days of summer adds to the comfort and well being of the fowls, and thus increases the profit which may be derived from them.

BREED TO SELECT.

In connection with orcharding it is important to have the poultry work so arranged as to interfere as little as possible when the trees demand most attention, namely, in the spring, when it is necessary to spray, and in the autumn at harvest time. Keeping fowls for egg production can be made to meet this requirement more nearly than any other branch of the poultry business, hence an egg or general purpose breed should be selected. The Leghorns, Minorcas, Plymouth Rocks, Wyandottes, Rhode Island Reds or Orpingtons are all suitable for this purpose.

HOUSES FOR LAYERS.

Colony houses should be scattered through the orchard. The shape or size of these houses is quite immaterial, provided that the hens are not overcrowded, and that the houses are dry and comfortable. A house sixteen or eighteen feet wide and twenty feet long will accommodate about seventy-five fowls of the smaller breeds, and one house per acre would be sufficient. These houses should face the south or south-east, so as to receive as much sunshine as possible in winter. The back wall, on the north side of the house, should be double boarded, so as to be perfectly tight and warm, and the south side should be provided with an opening which can be closed in cold and stormy weather by a canvas or duck curtain. The porches should extend the entire length of the house at the rear, and should be provided with dropping boards, underneath which the nests may be located. For details of construction, and cost, see Bulletins 71 and 115 of this Station.

FEEDING THE LAYERS.

The dry mash system of feeding can be used. This reduces the cost of labor for feeding to a minimum. This system consists in keeping constantly available to the fowls a mixture of ground grains and beef scrap. A mixture which has been found to be very satisfactory at this station consists of equal parts by weight of corn meal, ground oats and wheat bran. To this mixture is added about ten per cent. of beef scrap. In addition to the dry mash the fowls should be fed at least once per day some whole grain, such as a mixture of corn, wheat and oats. In the winter time, when the fowls are confined to the houses, this should be scattered in the straw or litter, which should cover the floors of the houses. In summer the whole grain may be scattered outside.

If a number of houses are constructed, a horse and wagon should be provided, so that the routine operations of watering, feeding and picking up eggs can be done without too much expense. In summer, when the hens have free range, one trip late in the afternoon will be all that is required, as the fowls can be watered, fed whole grain and the eggs gathered at the same time. In winter it is usually necessary to make two rounds daily.

AMOUNT OF FOOD REQUIRED.

Laying hens of the size of Leghorns require from sixty to seventy pounds of grain and beef scrap per head yearly. At the present prices for grain, this will cost about one dollar per fowl per year.

NUMBER AND VALUE OF EGGS LAID.

Young fowls, properly fed and cared for and given free range in an orchard, as outlined above, will lay, at the very lowest estimate, ten dozen eggs per hen per year. At an average price of twenty-five cents per dozen these would be worth two dollars and fifty cents, or a profit, above the cost of feed, of one dollar and fifty cents per hen per year.

REPLENISHING THE FLOCK.

Pullets hatched early in the spring lay more eggs during the following year than older hens. The pullets also lay more freely in winter, when eggs are high in price. In order, therefore, to obtain the greatest profit from a flock of fowls, it is necessary to raise a large number of chickens each year to take the place of the old hens, which may then be disposed of. If the flock of layers numbers more than two or three hundred it will probably be wise to procure an incubator and a few brooders, so that the chickens can be raised without too much trouble and expense. It should be kept clearly in mind, however, that it is not nearly so easy to raise chickens successfully by artificial means as it is to raise them with hens in the old way; and, unless the attendant is willing to spend some time in learning how to hatch and care for chickens, it probably will be wisest to let the hens do this. If incubators and brooders are used, consult Bulletin 98 of this Station, entitled Raising Chicks Artificially.

After the chicks become old enough so that they do not need artificial heat, or after they have been weaned by the hens, they should be placed in colony houses holding small flocks and allowed unrestricted range in a portion of the orchard away from the laying stock. If insects are plentiful, and the range is not overstocked, they may be able to procure sufficient animal food, but frequently it is necessary to give them an additional supply of ground fresh meat and bone or beef scrap in order to keep them growing properly. After the chicks are six or eight weeks old, whole or cracked grain is better than too much ground feed. If they are intended for layers or breeders, they should be induced to take as much exercise as possible so as to develop strong vigorous constitutions.

When the chicks are twelve or fifteen weeks old the cockerels can be sorted out and sold for broilers. This gives the pullets additional room on the perches at night, and care should be exercised to see that the little colony houses do not become overcrowded at any time during the summer, through the growth of the birds, as the success or failure of the egg production during the following winter depends quite largely on whether the pullets are strong, vigorous and healthy.

A short time before the layers begin to moult in the fall they should be culled over, and a few of the best birds reserved for next year's breeders. The houses should then be cleaned, disinfected and put in readiness for the reception of the pullets, which should be moved into their winter quarters at the beginning of frosty weather.

MARKETING THE PRODUCT.

Eggs produced during the winter, spring and summer would be the principal product to be disposed of, and if the local demand is small, and the price consequently low, it should be borne in mind that the wholesale price of new laid fancy white eggs in New York City is frequently as high as forty-five cents per dozen during November, December and January, and that it costs only from two and one-half to three cents per dozen, in case lots, to ship eggs to that market from almost any place in this state.

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 117 JUNE 1, 1908

TOMATO NOTES

This bulletin contains notes upon the history of the tomato; the development of modern forms; breeding new varieties; field culture; tomato growing in winter; and financial returns.

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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TOMATO NOTES.*

W. M. MUNSON.

Next to the potato, the tomato stands, perhaps, at the head of the list of garden vegetables in commercial importance. In Maryland, New Jersey, Delaware, Ohio, Indiana, and to a rapidly increasing extent, in West Virginia, the crop is of special importance; while the greenhouses of New York and New England, and the newly developed truck fields of Florida, endeavor to supply the demand for this fruit in winter.

By far the larger portion of the area devoted to this crop is employed in supplying fruit for the canning factories, and it is the demand of the canneries which, more than any other, has given the great impetus to tomato culture. The credit of introducing canned tomatoes as an article of trade, is due to Mr. Harrison W. Crosby, who made his first venture in 1848, while steward of Lafayette College, Easton, Pennsylvania. There was a ready demand for the goods and, with increased supply and improved machinery, the cost has been reduced from 50 cents per can in 1848 to 7 cents at the present time. With this reduced cost, the output of the factories has increased to an almost incredible extent. The total output of the United States, for 1887, was about 3,000,000 cases, of 24 cans each. In 1894, the output was nearly doubled; while in 1904 the

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* The tomato has been a crop of special interest to the writer of this bulletin for more than 20 years, and during that time various notes and observations have been published. Most of these observations were made in connection with the work of the Cornell University, and the Maine Agricultural Experiment Station; hence the frequent references to bulletins of those stations in the present discussion. At the request of the Director of this Station, and because of the value of this crop to the state, special attention will be given to its requirements and development.—W. M. M.

9,000,000 mark was reached, and in 1907 the pack reported was approximately 13,000,000 cases. There are no separate data for West Virginia, but for Virginia and West Virginia, the estimated pack for 1907 was approximately 1,000,000 cases.[1]

HISTORY AND CLASSIFICATION.

The garden varieties of tomatoes belong to two distinct species: *Lycopersicum pimpinellifolium*, Duval, and *Lycopersicum esculentum*, Miller. The former is represented in the garden by the "Currant" or "German Raisin," and is of weak, spreading habit, with small thin foliage and delicate flowers, arranged in two ranks on a long raceme. The whole aspect of the plant is delicate, and the long racemes of fruit are not unlike large clusters of currants. This species is found wild in Peru and Brazil, but little is known of its history. It has not been modified by domestication; and probably has not been long under cultivation. The chief value of this species, aside from its use as an ornamental plant, and to a limited extent for preserves, is in breeding new types. Some work in this direction has been done by the writer;[2] also by Bailey and others at the Cornell University Experiment Station.[3] The resulting hybrids are very unstable, however, and, as a rule, the fruit is too small to be of commercial importance.

Lycopersicum esculentum, the ordinary tomato, is undoubtedly a native of Peru, but is spontaneous or indigenous throughout Mexico and as far north as Texas and California, in a form closely approaching the Cherry tomato of the gardens. It was probably first cultivated in the south of Europe, where it is mentioned as early as 1561.[4] In 1583 the "fruit was eaten upon

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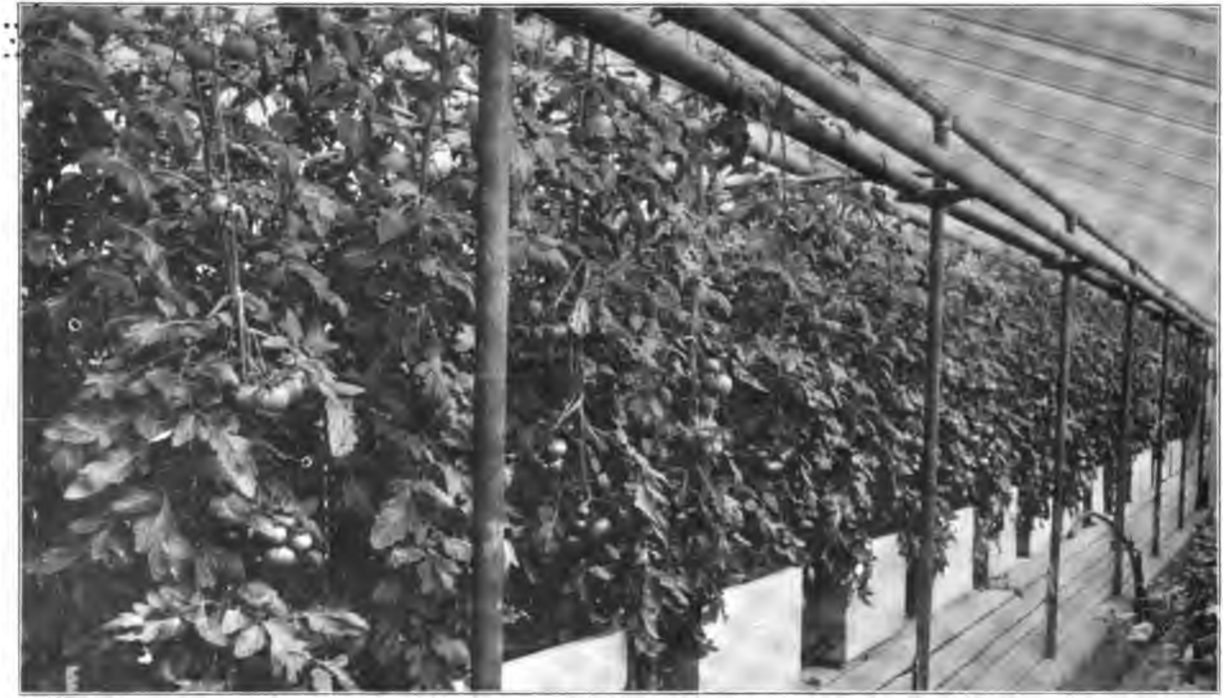
[1] Am. Grocer.

[2] Ann. Rept. Maine Expt. Sta., 1892, pp. 65-69.

[3] Cornell Univ. Expt. Sta. Bul. 32, p. 165.

[4] Anguillaria, Simp., 217.



Tomato Growing in Winter. (See page 259.)

the continent, dressed with pepper, salt and oil."[5] It was grown in England in 1597,[6] but for many years was used only for ornament. In 1700 Tourneforte[7] mentions 7 varieties, one of which was pale red, one striped, two yellow, one white, and two red; but the culture was still neglected, for more than 100 years later, in 1819, only 4 red varieties are mentioned, and the pale red sort is not named.[8]

Our own country was much later even than England in taking up the general culture of the tomato. The fruit is said to have been introduced into Philadelphia by a French refugee from San Domingo, in 1798.[9] In 1806, McMahon writes:[10] "The tomato is much cultivated for its fruit in soups and sauces * * * and is also stewed and dressed in various ways and very much admired." It was introduced into Salem, Massachusetts, about 1802, by an Italian painter, Corne, "but he found it difficult to persuade the people even to taste the fruit."[11]

The tomato began to be cultivated for market in this country about 1829, but not until 1839 was it mentioned in the premium lists of the leading horticultural societies.[12]

DEVELOPMENT OF THE MODERN TOMATO.

The orginal wild type of the garden tomato was probably, as suggested by Bailey,[13] very similar to the Cherry tomato of the present day. The tomato, however, is of exceedingly variable habit, and is readily susceptible to the influence of selection. Its variability lies mainly in size, form, and number of cells. In nature there is usually a definite number of cells in the fruit of any given species, but one of the first effects of cultivation is to render this character inconstant. In the wild tomato there are normally 2 cells; in the cultivated varieties, almost as many different forms and combinations of cells as there are individual fruits. "The effect of cultivation has been to increase the size of the fruit by the interposition of new cells, this condition resulting in the angular shapes characterizing many of the garden forms. In other words, the modern large fruited and irregular sorts have been developed, first, by the augmentation of cells in the primative type, and later by the modification of the flower and the production of an abnormal number of parts."[14]

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[5] Dodonæi Stirp. Hist., 455.

[6] Gerarde, Herballe, 275.

[7] Inst. Rei. Herb. 1, 150.

[8] Trans. Lond. Hort. Socy., III, 347.

[9] Manning, Hist. Mass. Hort. Soc., 40.

[10] McMahon Gard. Calendar, 319.

[11] Felt, Annals of Salem II, 631; cited by Manning, Hist. Mass. Hort. Soc., 40.

[12] Manning, Hist. Mass. Hort. Soc., 40.

[13] Am. Naturalist, June, 1887, 573; also Bul. 31, Mich. Agr. Coll. The exhaustive study by Bailey of the evolution of the tomato is the best published, and I draw freely from his discussion without further credit.—W. M. M.

The history of the introduction of the well known garden varieties, is of recent date. The old "Large Red," of the earlier catalogs, was followed in 1862 by Fiji Island and in 1869 by the Cook's Favorite. In 1866 Tilden appeared, and then in rapid succession Maupay, Keye's Extra Early, Boston Market, General Grant, Trophy and Paragon.

Paragon, the first of the many good varieties originated by the veteran tomato breeder A. W. Livingston, of Columbus, Ohio, was a marked step in advance over all former introductions. It was really the first of the round or apple shaped varieties to attain prominence, and gave a great impetus to the tomato as a field crop. It was a triumph for the application of correct principles of selection, for, in the production of this variety, the habit of the whole plant rather than the character of an individual fruit was considered.

In 1880, Perfection, another of Livingston's selections, appeared; and during the next 10 years, Favorite, Beauty, Dwarf Champion, Lorillard, Ignotum, and a host of less worthy sorts followed. Dwarf Champion was the first of the short jointed, thick leaved varieties to attain prominence; Lorillard, introduced in 1887, marked the special development of tomato growing under glass; Ignotum, originated at the Michigan Agricultural College and first cataloged in 1890, was specially noted for its large, smooth, meaty fruit, and marked the highest development of the tomato at that date.

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[14] Bailey, *loc. cit.*

Since 1890, Stone, Ruby, Aristocrat, and a host of other new varieties have appeared, but, except that some of the very early sorts have developed a smoother type of fruit, little real advance has been made in the commercial sorts. Each year, however, sees its addition to the list of commercial varieties offered for sale.

BREEDING NEW VARIETIES.

The production of new varieties of tomatoes has, in the main, been a work of selection from "sports," or chance seedlings, of special merit in some one direction. At the Maine Experiment Station, and also at Cornell University, some attention has been given to the production of hybrids between the two species but, as already noted, (page 252), these hybrids are as a rule small, and the resulting type is unstable. As the result of several years of crossing and selection, the writer succeeded in producing a type which was well adapted to use under glass.[15] The fruit of this hybrid was too small for general field culture, however.

Crosses between Ignotum and Peach, also between Lorillard and Peach,—the latter an early and very productive sort which, however, is too soft for market—resulted in a marked increase in the number of fruits maturing before frost but with a considerably reduced size; and in the second and third generations the effect upon the earliness of the crop was much less noticeable.[16]

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[15] Ann. Rept. Maine Agr. Expt. Sta., 1892, p. 68; also *Ibid*, 1894. p. 28, with Plates I. and IV.

Attempts have been made to produce yellow fruits with a blush cheek by crossing red fruited and yellow fruited types. As a rule, however, no satisfactory results have been obtained. In the writer's experience, the plants resulting from this cross invariably produced red fruits. One variety of this type, "Lemon Blush," was listed by a prominent seedsman; but, as grown in northern latitudes, the blush failed to appear. By continuous selection from Golden Queen, there was produced in the forcing houses of the Maine Experiment Station a type of this variety with distinctly blush cheek; but as grown in the field. this characteristic disappeared.

The importance of the character of the plant, rather than of the individual fruit, in selecting for new varieties or for general crop, is a matter of general observation. The importance of this factor in breeding was emphasized by the results obtained at the Cornell University Experiment Station.[17] "Two lots of tomatoes, (Volunteer, being the variety used), were grown under like conditions. One lot was from commercial seeds, and was in every way typical of the variety. The other lot was grown from seeds obtained from a small inferior fruit (only ¾ inch in diameter) which was taken from a plant bearing mostly large fruits. The yield from the first lot—commercial seeds—previous to frost, was 6.7 lbs. per plant, with an average weight per fruit of 5.3 oz. The yield from the second lot was 8.8 lbs. per plant, with an average of 7.3 oz. per fruit. Similar results were obtained with the Mikado." In this way, by selecting individual plants in a field, smoother varieties; earlier, more productive or better types are produced.

That varieties "run out," or lose their distinguishing characteristics, is beyond question. With careful selection on the part of the grower, however, a given type may be preserved for many years. "Running out" does not necessarily mean deterioration. A variety may be developed into a decidedly improved type, by attention to seed selection; as has been the case with Trophy, Mikado, Ruby, and some other very angular sorts.

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[16] Ann. Rept. Maine Agr. Expt. Sta., 1892, pp. 65, 66; 1893, pp. 115, 116.

[17] Bailey and Munson, Cornell Univ. Expt. Sta., Bul. 21, p. 75.

CULTURAL NOTES.

Certain of the more salient points in the field management of this crop ,which have received the writer's attention during a somewhat extended study, are considered in this connection.

One of the most important problems in tomato culture is that of earliness. As a rule, plants purchased of the local dealers are drawn and "leggy," being crowded together in small boxes. When set in the field, where, too often, the soil is hard and dry, the shock is such that several weeks are required for the plants to recover, and no fruit sets until late in the season. In general, these weak drawn plants are not worth setting.

Frequent transplanting before setting in the field is the best method of securing strong, stocky, well developed plants. The practice usually followed by the writer has been to sow the seeds in hot beds, or in shallow boxes in the greenhouses, about April 1. When the first true leaves have well started, or as soon as the plants begin to crowd, transfer to 2-inch pots, and later to 3-inch and 4-inch if occasion demands. As a rule, however, in this climate, it will be unnecessary to handle the plants more than twice. In the absence of pots, the plants may be handled in boxes, or even in the bed; but pot-grown plants are always preferable, as they are checked less by removal to the field. In the field, the plants are set about 4x5 ft. Many would plant closer, but on reasonably rich ground the plants will cover the whole surface if set at this distance.

The plants should be set in the field as soon as danger from frost is past. It has commonly been taught that any chill is nearly fatal to young tomato plants; but, as shown by the writer's work at Cornell University,[18] and at the Maine Experiment Station, "a chill is not as fatal to success as is commonly supposed."[19] At the Maine station it was found that, "in every instance, save one, the first ripe fruits were obtained from plants set latest. This fact, however, is not necessarily an indication of earliness, as the late set plants were older than is usually desirable for setting, and the first fruits were in some cases from blossoms formed while in the house. After these had ripened, there was a long interval before others followed. "Without exception, the average number of fruits, and the average weight of the product, per plant, was in direct ratio with the earliness of setting.'"[20] These facts are in direct confirmation of results obtained in the two preceeding years.

The question of fertilization was touched upon in Bulletin 116, of this Station. As there stated,[21] the notion that tomatoes do better upon relatively poor soil, is erroneous. While it is doubtful if an excessively heavy application of stable manure would be profitable, a liberal application, such as would be given for a good crop of corn, may nearly always be used with advantage. At the Cornell Experiment Station it was found that, "the results obtained with liberal manuring, under commercial conditions, * * * certainly show that good stable manure in abundance could be used profitably.'"[22]

Some of the best tomato soils are the newly cleared areas designed for orchard planting. But on these same new soils, an application of about 500 lbs. of a good high grade complete fertilizer will usually be found advantageous.

Trimming the vines, in midsummer, as a means of hastening maturity and increasing the yield of fruit, is frequently recommended, but very seldom practiced, even by amateurs. In the writer's experience the results obtained justify greater emphasis of this point. As a result two of successive season's work, at the Maine Experiment Station,[a] it was found that the total increase in the number of fruits matured, due to trimming, ranged from 5.5 per cent to 50 per cent. The percentage gain by weight, was very marked and in one instance reached a total of 58 per cent. In these trials, the plants were grown under ordinary field culture. They were started in the greenhouse April 1; planted in the field June 1; and headed back July 24, August 8, and September 5. At each trimming the leading branches were shortened about 6 inches, and most of the side shoots below the first clusters of fruit were removed, the others being shortened. The sunlight was thus freely admitted to the fruit, and picking was rendered much easier.

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[18] Cornell Univ. Expt. Sta. Bul. 21, p. 79.

[19] Ann. Rept. Maine Agr. Expt. Sta., 1892, p. 62.

[20] Ann. Rept. Maine Expt. Sta., 1892, p. 63.

[21] Bulletin 116, W. Va. Agr. Expt. Sta., p. 221.

[22] Cornell Univ. Expt. Sta. Bul. 21, p. 78.

TOMATO GROWING IN WINTER.

Successful tomato culture under glass, depends as much upon the man in charge as upon conditions. Eternal vigilance and the exercise of good judgment on the part of the grower are more essential than strict adherence to set rules. The crop is one which demands constant care and intelligent management, but under suitable conditions the returns are very satisfactory; and the product meets a ready demand at good prices.

The most important conditions for forcing tomatoes are: A warm light house—one having a two-thirds span facing the south being preferable—strong bottom heat, rich soil, careful training, uniform temperature, care in watering and pollinating, and, as before suggested, good judgment and constant watchfulness on the part of the grower. Bottom heat is not absolutely essential to success, but the crop matures more quickly if given this condition.

To make the best use of the house, two crops should be grown during the season. This will bring each crop on at a season when the expense of heating, during a part of the time, will be slight. Plants for the first crop should be started as early as the first of August. If two or more houses are available, a second sowing should be made in about 3 weeks, to give a succession. For the second crop, seed should be sown during the latter part of October.

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[a] Ann. Rept. Maine Agr. Expt. Sta., 1891, p. 89.

The plants are treated in every way as for out-door culture till handled the last time. For fruiting, some prefer benches, with about 6 inches of soil; but, in the writer's experience, the best results have been obtained from the use of boxes 18 inches square and 12 inches deep.[24] In the bottom of the boxes is placed a layer of charcoal, broken pots, or "clinkers" from the furnace; after which soil, consisting of 3 parts good garden loam and 1 part well rotted stable manure, is filled in to within 2 or 3 inches of the top. Each box will hold 4 plants, and the check caused by the partial confinement of the roots seems to be of value in hastening maturity. If the solid bed is used, instead of the boxes, the plants are set about 16 inches apart each way, thus occupying a little more than 1½ square feet of floor space, for each plant.

Best returns usually follow where the plants are trained to a single stem, as shown in plate 2. Flax cords, about the size of wool twine, are fastened to the corners of the boxes, or to wires placed parallel to each row, for that purpose, and attached above to wires running lengthwise of the building, on the rafters or sashbars. The plants are secured loosely to this support by means of short pieces of raffia. All side shoots should be pinched out as soon as they appear; and when the plants are about 5 feet high, or when 4 clusters of fruit have set, the terminal buds should be pinched off. The vitality of the plant will then be expended in the development of fruit. If the plants are not headed back, other fruit clusters will form, but these scattering later clusters will unduly prolong the fruiting season without giving sufficient financial return to warrant delaying the removal of the old plants.

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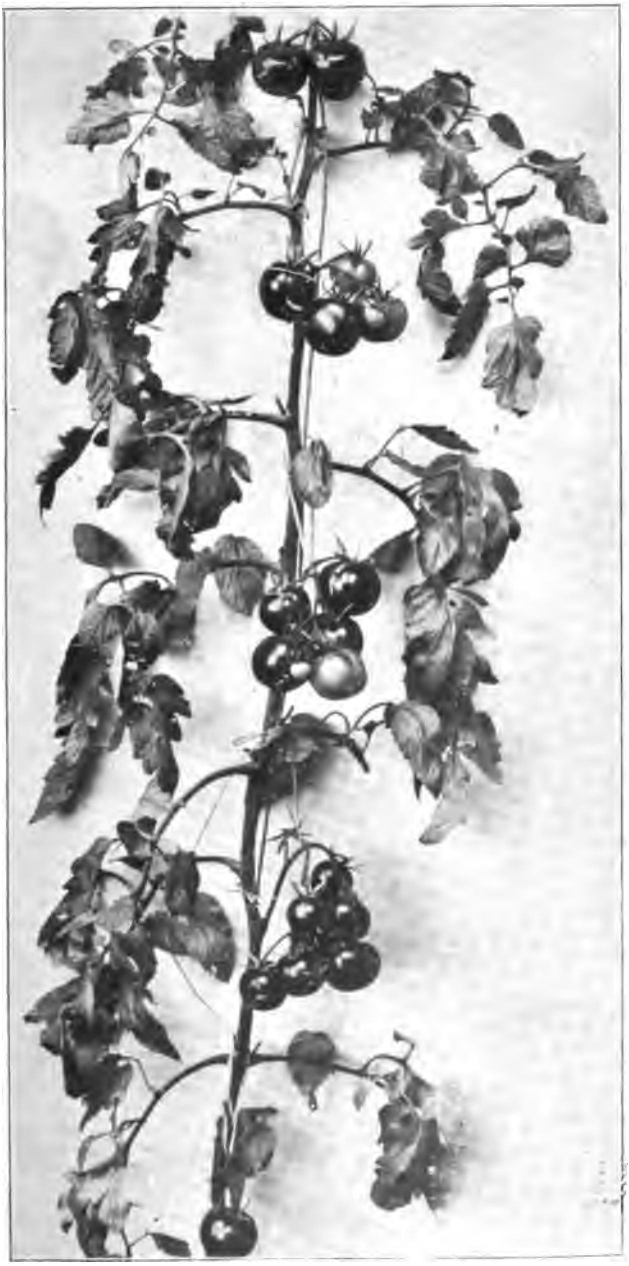
[24] Ann. Rept. Maine Agr. Expt. Sta., 1894, pp. 58-60.



SINGLE-STEM TRAINING. (See page 260.)

As the fruit sets, the clusters should be supported by means of a small cord or piece of raffia passing around the main stem above a leaf, thus forming a sling. At this time, too, it is well to stir the surface of the soil, and work in a quantity of well-rotted manure, or to give frequent applications of liquid manure.

The temperature of the house should be as nearly uniform as possible,—about 60° at night and 70° in dark weather, but 80° or even higher on bright sunny days. All cold drafts and sudden changes of temperature should be rigidly avoided.

FINANCIAL RETURNS.

The writer's experience in forcing tomatoes, is limited to New York and New England, where, owing to the low temperatures and the excessive number of dark cloudy days, the yields were not large. In Maine,[25] the yield per plant, with the best forcing varieties, was 2½ to 3 lbs. In New Jersey the average yield reported is somewhat larger. On the basis of 3 lbs. per plant, however, the returns at 30 cents per pound, or 25 cents at wholesale, are very profitable; being about 50 cents per square foot of bench space, for each crop. Of course these figures cannot always be relied upon, for unforeseen conditions frequently arise; but, on the other hand, the experienced gardener will, by the use of other crops, as lettuce, radishes and cucumbers, utilize the space in the house so as to provide against these unforeseen factors.

The average yield per acre, as grown for the canneries, is 125 to 150 bushels. The man who makes a specialty of tomatoes however, will not be content with less than twice the amount named. It is better to cultivate fewer acres and cultivate them well, than to attempt to cover too much ground. Even at 200 bushels per acre, however, the returns will be far greater than can be derived from wheat, corn, or other farm products.

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[25] Ann. Rept. Maine Agr. Expt. Sta., 1894, p. 62.

No attempt is made, to exert undue influence, by citing special instances of large crops or of large prices. As a simple business proposition, however, tomato growing offers excellent opportunities at this time.

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 118 DECEMBER 31, 1908

Commercial Fertilizers

COMPLETE REPORT

FOR

1908

BY J. H. STEWART AND B. H. HITE

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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Horace Atwood, M. S. Agr	Assistant Agriculturist
Fred E. Brooks	Associate Entomologist
Frank B. Kunst, A. B	Assistant Chemist
Chas. E. Weakley, Jr	Assistant Chemist
J. H. Berghuis Krak	Assistant Chemist
A. L. Dacy, B. Sc	Assistant Horticulturist
W. J. White	Bookkeeper
M. A. Stewart	Librarian
Alice Engle	Stenographer
B. D. White	Herdsman
Theo. F. Imbach	Greenhouseman

Commercial Fertilizers

Complete Report for 1908

Bulletin 118

The following is a complete report of the work required of this Experiment Station by the Fertilizer Law of this State during the year ending Dec. 31, 1908.

This report shows that there is an abundance of excellent fertilizers for all purposes regularly on sale in almost every section of the State. There is also an abundance of low grade fertilizers and a very manifest determination to dump as much of them as possible into this State. This involves no violation of any statute. When the manufacturers of these low grade fertilizers state that they are low grade, make oath to the statement and pin it all over the packages, there is nothing more that legislation can do.

The losses and disappointments attending the use of low grade fertilizers were treated at some length in the Fertilizer Report of last year, copies of which may yet be had for the asking.

THE AMERICAN AGRICULTURAL CHEMICAL CO.,

No. 2 Rector Street, New York City and 741 Equitable Building,
Baltimore, Md.

6043. A. A. C. Co.'s Pure Ground Bone, Thos. Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, total, 20.60; nitrogen, 3.30; phosphoric acid from animal bone, nitrogen from animal bone. Found: Phosphoric acid, total, 24.54; nitrogen, 3.53; availability of nitrogen, 89.

6187. A. A. C. Co.'s Pure Ground Bone, Thos. Nuzum, Agent, Grafton, W. Va. Guarantee: (As above). Found: Phosphoric acid, total, 23.64; nitrogen, 3.76; availability of nitrogen, 85.

6050. A. A. C. Co.'s Fine Ground Bone, Johnson & Gwinn, Agent, Alderson, W. Va. Guarantee: Phosphoric acid, total, 22.80; nitrogen, 2.47; phosphoric acid from animal bone, nitrogen from animal bone. Found: Phosphoric acid, total, 23.99; nitrogen, 2.38; availability of nitrogen, 93.

6096. A. A. C. Co.'s Bone Meal, Siever Hardware Co., Agent, Keyser, W. Va. Guarantee: Phosphoric acid, total, 13.75; nitrogen, 1.65; phosphoric acid from animal bone, nitrogen from animal bone. Found: Phosphoric acid, total, 15.19; nitrogen, 1.61; availability of nitrogen, 89.

6042. A. A. C. Co.'s Gem Alkaline Phosphate, Thos. Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble, 4; reverted, 2; insoluble, 1; total, 7; available, 6: potash, 3; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble, 2.32; reverted, 3.91; insoluble, 0.40; total, 6.63; available, 6.23; potash, 2.90; chlorine, 6.2.

Remark: Chlorine excessive.

6084. A. A. C. Co.'s Gem Alkaline Phosphate, T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 1.80; reverted, 4.52; insoluble, 0.38; total, 6.70; available, 6.32; potash, 3.20; chlorine, 5.5.

Remark: Chlorine excessive.

6132. A. A. C. Co.'s Gem Alkaline Phosphate, R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 2.25; reverted, 4.05; insoluble, 0.40; total, 6.70; available, 6.30; potash, 3.63; chlorine, 4.8.

Remark: Chlorine excessive.

6049. Big Crop Phosphate, Johnson & Gwinn, Alderson, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; potash, 5; phosphoric acid from dissolved phosphate rock, potash from manure salt. Found: Phosphoric acid, soluble, 4.18; reverted, 4.05; insoluble, 0.55; total, 8.78; available, 8.23; potash, 5.06; chlorine, 2.8.

Remark: Source of potash equivalent to kainit.

6081. Big Crop Phosphate, T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.10; reverted, 5.41, insoluble, 0.70; total, 9.21; available, 8.51; potash, 5.36; chlorine, 3.

Remark: Source of potash equivalent to kainit.

6206. Dissolved Animal Bone, T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 10; reverted, 2; insoluble, 1; total, 13; available, 12; nitrogen, 2.06; phosphoric acid from animal bone, nitrogen from animal bone. Found: Phosphoric acid, soluble, 9.54; reverted, 2.62; insoluble, 3.19; total, 15.35; available, 12.16; nitrogen, 2.27; availability of nitrogen, 92.

6022. Corn, Oats and Buckwheat Fertilizer, Cicero Phillips, Agent, Belington, W. Va. Guarantee: Phosphoric acid, soluble, 4; reverted, 2; insoluble, 1; total, 7; available, 6; potash, 3; phosphoric acid from dissolved phosphate rock, potash from kainit. Found: Phosphoric acid, soluble, 2.01; reverted, 4.56; insoluble, 0.47; total, 7.04; available, 6.57; potash, 2.90; chlorine, 5.8.

Remark: Chlorine excessive.

6040. High Grade Dissolved Bone & Potash, Thos. Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 5; phosphoric acid from dissolved phosphate rock, potash ¼ to ¾ manure salts, ¼ to ¾ muriate of potash.

Found: Phosphoric acid, soluble, 5.58; reverted, 4.44; insoluble, 0.56; total, 10.58; available, 10.02; potash, 5.76: chlorine, 3.

Remark: Source of potash equivalent to kainit.

6127. Genuine German Kainit, Washington, Alexander & Cooke, Charlestown, W. Va. Guarantee: Potash, 12; potash from kainit. Found: Potash, 12.06; chlorine, 2.8.

6203. Super-phosphate, Geo. B. Hooff, Charlestown, W. Va. Guarantee: Phosphoric acid, soluble, 14; reverted, 2; insoluble, 1; total, 17; available, 16; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 8.62; reverted, 9.32; insoluble, 0.24; total, 18.18; available, 17.94.

6041. Bradley's Bean & Potato Phosphate, Thos. Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8: nitrogen, 0.82; potash, 4; phosphoric acid from dissolved phosphate rock and dissolved animal bone, nitrogen from animal tankage, potash ¼ to ¾ from manure salts, ¼ to ¾ kainit. Found: Phosphoric acid, soluble, 4.23; reverted, 4.22; in. soluble, 1.18; total, 9.63; available, 8.45; nitrogen, .98; potash, 4.48; availability of nitrogen, 77; chlorine, 2.7.

Remark: Chlorine excessive.

6176. Bradley's Bean & Potato Phosphate, Thompson & Ireland, Worthington, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 4.22; reverted, 4.33; insoluble, 1.39; total, 9.94; available, 8.55; nitrogen, 1.07; potash, 4.63: availability of nitrogen, 77; chlorine, 2.5.

6044. Bradley's Niagara Phosphate, Thos. Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 2; insoluble, 1; total, 8; available, 7; nitrogen, 0.82; potash, 1; phosphoric acid from dissolved animal bone and dissolved phosphate rock, nitrogen from animal tankage, potash from kainit. Found: Phosphoric acid, soluble, 3.52; reverted, 3.72; insoluble, 0.92; total, 8.16; available, 7.24; nitrogen, 0.97; potash, 1.21; availability of nitrogen, 78; chlorine, 6.7.

Remark: Chlorine excessive.

6080. Bradley's Niagara Phosphate, Geo. E. Rogers, Agent, Rowlesburg, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.85; reverted, 3.48; insoluble, 1.04; total, 8.37; available, 7.33; nitrogen, 0.94; potash, 1.34; availability of nitrogen, 75; chlorine, 5.9.

Remark: Chlorine excessive.

6151. Bradley's Niagara Phosphate, Thompson & Ireland, Agent, Worthington, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.24; reverted, 4.40; insoluble, 1.06; total, 8.70; available, 7.64; nitrogen, 0.91; potash, 1.25; availability of nitrogen, 77; chlorine, 7.2.

Remark: Chlorine excessive.

6148. Bradley's Soluble Dissolved Bone, Thompson & Ireland, Agent, Worthington, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 10.40; reverted, 4.47; insoluble, 1.07; total, 15.94; available, 14.87.

6177. Bradley's Alkaline Bone & Potash, Thompson & Ireland, Agent, Worthington, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 2; phosphoric acid from dissolved phosphate rock, potash from kainit. Found: Phosphoric acid, soluble, 4.86; reverted, 5.09; insoluble, 0.69; total, 10.64: available. 9.95; potash, 2.07; chlorine, 5.

Remark: Chlorine excessive.

6186. Bradley's Dissolved Bone with Potash, Thos. Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 1.03; potash, 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock, nitrogen from animal tankage, potash from kainit. Found: Phosphoric acid, soluble, 5.86; reverted, 2.61; insoluble, 1.02; total, 9.49; available, 8.47; nitrogen, 1.05; potash, 2.32; availability of nitrogen, 73; chlorine, 4.1.

Remark: Chlorine excessive.

6036. Canton Chemical Potato & Tobacco Manure, R. W. Sovine, Agent, Hurricane, W. Va. Guarantee: Phosphoric acid, soluble, 4; reverted, 2; insoluble, 1; total, 7; available, 6; nitrogen, 1.24; potash, 5; phosphoric acid from dissolved animal bone and dissolved phosphate rock, nitrogen from animal tankage, potash, ¼ to ¾ from manure salt, ¼ to ¾ from kainit. Found: Phosphoric acid, soluble, 4.80; reverted, 3.91; insoluble, 2.09; total, 10.80; available, 8.71; nitrogen, 1.07; potash, 5.92; availability of nitrogen, 84; chlorine, 1.1.

Remark: Nitrogen low.

6098. Canton Chemical Potato Manure, Siever Hardware Co., Agent, Keyser, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.01; reverted, 3.76; insoluble, 1.43; total, 8.20; available, 6.77; nitrogen, 1.44; potash 5.39; availability of nitrogen, 81; chlorine, 2.6.

Remark: Source of potash equivalent to kainit.

6129. Canton Chemical Potato & Tobacco Manure, Washington, Alexander & Cooke, Agents, Charlestown, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.77; reverted, 3.10; insoluble, 0.74; total, 7.61; available, 6.87; nitrogen, 1.26; potash, 5.38; availability of nitrogen, 78; chlorine, 2.6.

Remark: Source of potash equivalent to kainit.

6097. Canton Chemical Baker's Special Wheat, Corn and Grass Mixture, Siever Hardware Co., Agent, Keyser, W.

Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 2; insoluble, 1; total, 10; available, 9; nitrogen, 0.82; potash, 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock, nitrogen from animal tankage, potash from kainit. Found: Phosphoric acid, soluble, 5.30; reverted, 3.17; insoluble, 1.24; total, 10.71; available, 9.47; nitrogen, 1.11; potash, 2.21; availability of nitrogen, 74; chlorine, 2.9.

6125. Canton Chemical Baker's Special Wheat, Corn and Grass Mixture, Washington, Alexander & Cooke, Agents, Charlestown, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 5.41; reverted, 4.25; insoluble, 1.20; total, 10.86; available, 9.66; nitrogen, 0.90; potash, 1.96; availability of nitrogen, 69; chlorine, 2.9.

6099. Canton Chemical Baker's Dissolved S. C. Bone, Siever Hardware Co., Agent, Keyser, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, 10.94; reverted, 4.52; insoluble, 1.15; total, 16.61; available, 15.46.

6126. Canton Chemical Baker's Dissolved S. C. Bone, Washington, Alexander & Cooke, Agents, Charlestown, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 9.58; reverted, 4.26; insoluble, 1.18; total, 16.02; available, 14.84.

6147. Canton Chemical Baker's Dissolved S. C. Bone, J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 10.63; reverted, 4.99; insoluble, 1.10; total, 16.72; available, 15.62.

6101. Canton Chemical Harrow Brand Crop Grower, T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 1; phosphoric acid from

6240. Detrick's Kangaroo Komplete Kompound, J. M. Miller & Bro., Agent, Ronceverte, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 6.19; reverted, 3.17; insoluble, 1.13; total, 10.49; available, 9.36; nitrogen, 1.76; potash, 3.21; availability of nitrogen, 75; chlorine, 2.5.

6034. Detrick's Imperial Compound, W. H. McCallister, Agent, Hurricane, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock, nitrogen from animal tankage. potash from kainit. Found: Phosphoric acid, soluble, 4; reverted, 4.23; insoluble, 2.29; total, 10.52; available, 8.23; nitrogen, 0.97; potash, 1.91; availability of nitrogen, 77; chlorine, 1.1.

6169. Detrick's Corn & Oats Fertilizer, W. S. Corrothers, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 2; insoluble, 1; total, 10; available, 9; nitrogen, 0.82; potash, 3; phosphoric acid from dissolved animal bone and dissolved phosphate rock, nitrogen from animal tankage, potash, ¼ to ¾ manure salts, ¼ to ¾ kainit. Found: Phosphoric acid, soluble, 6.70; reverted, 2.71; insoluble, 1.28; total, 10.69; available, 9.41; nitrogen, 0.92; potash, 3.54; availability of nitrogen, 72; chlorine, 2.2.

6170. Detrick's Paragon Ammoniated Bone Phosphate & Potash, W. S. Corrothers, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 2; insoluble, 1; total, 8; available, 7; nitrogen, 0.82; potash, 1; phosphoric acid from dissolved animal bone and dissolved phosphate rock, nitrogen from animal tankage, potash from kainit. Found: Phosphoric acid, soluble, 4.12; reverted, 3.37; insoluble, 0.92; total, 8.41; available, 7.49; nitrogen, 0.91; potash, 1.27; availability of nitrogen, 75; chlorine, 6.3.

Remark: Chlorine excessive.

6171. Detrick's Dissolved S. C. Bone, W. S. Corrothers, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 10.21; reverted, 4.89; insoluble, 1.15; total, 16.25; available, 15.10.

6060. Great Eastern High Grade Bone & Potash, E. R. Judy, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 5; phosphoric acid from dissolved phosphate rock, potash, ¼ to ¾ manure salts; ¼ to ¾ muriate of potash. Found: Phosphoric acid, soluble, 4.89; insoluble, 0.84; reverted, 5.64; total, 11.37; available, 10.53; potash, 5.18; chlorine, 1.9.

Remark: Source of potash equivalent to manure salts.

6118. Great Eastern High Grade Bone & Potash, J. D. Anderson, Agent, Ronceverte, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 4.77; reverted, 4.74; insoluble, 1.05; total, 10.56; available, 9.51; potash, 5.14; chlorine, 2.1.

Remark: Phosphoric acid low.

6238. Great Eastern High Grade Bone & Potash, Coleman & Gribbs, Agent, Farmington, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 5.53; reverted, 4.63; insoluble, 1.01; total, 11.17; available, 10.16; potash, 5.85; chlorine, 2.3.

Remark: Chlorine excessive.

6062. Great Eastern English Wheat Grower, E. R. Judy, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock, nitrogen from animal tankage, potash from kainit. Found: Phosphoric acid, soluble, 4.49; reverted, 3.98; insoluble, 0.87; total, 9.34; available, 8.47; nitrogen, 1.02; potash, 2.28; availability of nitrogen, 81. chlorine, 3.1.

Remark: Chlorine excessive.

6120. Great Eastern Corn Fertilizer, J. D. Anderson, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 4; phosphoric acid from dissolved animal bone and dissolved phosphate rock; potash, ¼ to ¾ manure salts, ¼ to ¾ kainit; nitrogen from animal tankage. Found: Phosphoric acid, soluble, 5.09; reverted, 3.72; insoluble, 0.91; total, 9.72; available, 8.81; nitrogen, 0.95; potash, 4.21; availability of nitrogen, 72; chlorine, 2.

6138. Great Eastern Corn Fertilizer, C. E. Casler, Agent, Berkeley Springs, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 4.55; reverted, 5.09; insoluble, 1.34; total, 10.98; available, 9.64; nitrogen, 0.87; potash, 4.68; availability of nitrogen, 73; chlorine, 3.4.

Remark: Source of potash equivalent to kainit. Chlorine excessive.

6146. Great Eastern Corn Fertilizer, Coleman & Gribbs, Agent, Farmington, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.53; reverted, 5.15; insoluble, 1.36; total, 10.04; available, 8.68; nitrogen, 1.02; potash, 5.44; availability of nitrogen, 74; chlorine, 2.2.

6121. Great Eastern Dissolved Bone, J. D. Anderson, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 11.86; reverted, 4.78; insoluble, 0.41; total, 17.05; available, 16.64.

6141. Great Eastern Dissolved Bone, C. E. Casler, Agent, Berkeley Springs, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 9.98; reverted, 5.51; insoluble, 1.24; total, 16.73; available, 15.49.

6135. Great Eastern Soluble Bone & Potash, C. E. Casler, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 2; phosphoric acid from dissolved phosphate rock, potash from kainit. Found: Phosphoric acid, soluble, 6.06; reverted, 5.10; insoluble, 0.69; total, 11.85; available, 11.16; potash, 2.01; chlorine, 5.

Remark: Chlorine excessive.

6150. Great Eastern Japanese Wheat Grower, Coleman & Gribbs, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble, 4; reverted, 2; insoluble, 1; total, 7; available, 6; potash, 3; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble, 2.15; reverted, 4.56; insoluble, 0.54; total, 7.25; available, 6.71; potash, 5.20; chlorine, 3.1.

Remark: Chlorine excessive.

6228. Great Eastern Japanese Wheat Grower, Coleman & Gribbs, Farmington, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.61; reverted, 3.26; insoluble, 0.13; total, 7; available, 6.87; potash, 3.58; chlorine, 5.2.

Remark: Chlorine excessive.

6083. Lazaretto Special Potato & Tobacco Fertilizer, T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 4; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen from animal tankage; potash, ¼ to ¾ manure salts, ¼ to ¾ kainit. Found: Phosphoric acid, soluble, 3.90; reverted, 4.70; insoluble, 1.15; total, 9.75; available, 8.60; nitrogen, 0.86; potash, 4.30; availability of nitrogen, 70; chlorine, 2.6.

Remark: Source of potash equivalent to kainit.

6082. Lazaretto Dissolved Bone & Phosphate, T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 10.50; reverted, 5.11; insoluble, 1.11; total, 16.72; available, 15.61.

6179. Maryland Tornado Fertilizer, Seslir & Hawker Hdw. Co., Agent, Shinnston, W. Va. Guarantee: Phosphoric acid, soluble, 10; reverted, 2; insoluble, 1; total, 13; available, 12; potash, 5; phosphoric acid from dissolved phosphate rock; potash from muriate of potash. Found: Phosphoric acid, soluble, 9.54; reverted, 3.51; insoluble, 0.75; total, 13.80; available, 13.15; potash, 5.48; chlorine, 2.

Remark: Source of potash equivalent to manure salts.

6180. Maryland's Dissolved S. C. Phosphate, W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 10.77; reverted, 4.74; insoluble, 0.99; total, 16.50; available, 15.51.

6225. Maryland's Dissolved S. C. Phosphate, W. S. Stout, Agent, Harrisville, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 11.85; reverted, 3.96; insoluble, 0.23; total, 16.04; available, 15.81.

6037. Williams & Clark's Good Grower Potato Phosphate, A. G. Crislip, Agent, Philippi, W. Va. Guarantee:

Phosphoric acid, soluble, 4; reverted, 2; insoluble, 1; total, 7; available, 6; nitrogen, 1.24; potash, 5; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen from animal tankage. Potash, ¼ to ¾ from manure salts, ¼ to ¾ from kainit. Found: Phosphoric acid, soluble, 3.39; reverted, 3.46; insoluble, 1.47; total, 8.32; available, 6.85; nitrogen, 1.44; potash, 5.18; availability of nitrogen, 86; chlorine, 2.7.

Remark: Source of potash equivalent to kainit.

6038. William's & Clark's Acorn Acid Phosphate, A. G. Crislip, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 10.62; reverted, 4.85; insoluble, 0.75; total, 16.22; available, 15.47.

6039. Williams and Clark's Prolific Fertilizer, A. G. Crislip, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 2; insoluble, 1; total, 8; available, 7; nitrogen, 0.82; potash, 1; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen from animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 3.72; reverted, 3.65; insoluble, 0.92; total, 8.29; available, 7.37; nitrogen, 0.92; potash, 1.16; availability of nitrogen, 81; chlorine, 7.

Remark: Chlorine excessive.

6226. Williams & Clark's Royal Bone Phosphate, Wheeling Implement Buggy Co., Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 1.03; potash, 2; phosphoric, acid from dissolved animal bone and dissolved phosphate rock; nitrogen from animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 4.68; reverted, 3.97; insoluble, 1.98; total, 10.63; available, 8.65; nitrogen, 1.12; potash, 2.44; availability of nitrogen, 79, chlorine, 2.9.

6236. Southern Fertilizer Co.'s Bone & Potash Mixture, W. C. Hovemale & C. A. Rider, Agents, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; potash, 2; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble, 4.63; reverted, 4.02; insoluble, 0.32; total, 8.97; available, 8.65; potash, 2.56; chlorine, 7.2.

Remark: Chlorine excessive.

6224. Susquehanna Superior Rock Phosphate, W. N. Lemen & Son, Agent, Shephardstown, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 9.44; reverted, 5.52; insoluble, 0.83; total, 15.79; available, 14.96.

6023. Zell's Dissolved Bone Phosphate, Cicero Phillips, Agent, Belington, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14. Found: Phosphoric acid, soluble, 10.95; reverted, 4.57; insoluble, 1.01; total, 16.53; available, 15.52.

6114. Zell's Dissolved Bone Phosphate, Exchange Mill Co., Agent, Grafton, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 9.45; reverted, 5.53; insoluble, 1.01; total, 15.99; available, 14.98.

6024. Zell's Electric Phosphate, Cicero Philipps, Agent, Belington, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 2; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble, 6.17; reverted, 4.41; insoluble, 0.54; total, 11.12; available, 10.58; potash, 2.20; chlorine, 5.1.

Remark: Chlorine excessive.

6063. Zell's Electric Phosphate, Ira J. Curry, Agent, Grafton, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 6.28; reverted, 4.23; insoluble, 0.67; total, 11.18; available, 10.41; potash, 2.18; chlorine, 5.1.

Remark: Chlorine excessive.

6035. Zell's Little Giant, Mossman Bros., Agent, Huntington, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 2; insoluble, 1; total, 8; available, 7; nitrogen, 0.82; potash, 1; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen from animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 1.66; reverted, 5.20; insoluble, 2.65; total, 9.51; available, 6.86; nitrogen, 1.05; potash, 1.17; availability of nitrogen, 77; chlorine, 1.2.

Remark: Phosphoric acid low.

6134. Zell's Little Giant, R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.91; reverted, 4.67; insoluble, 1.09; total, 9.67; available, 8.58; nitrogen, 0.99; potash, 1.19; availability of nitrogen, 78; chlorine, 6.8.

Remark: Chlorine excessive.

6064. Zell's Special Compound for Potatoes and Vegetables, Ira J. Curry ,Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 2.47; potash, 4; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen from animal tankage; potash from muriate of potash. Found: Phosphoric acid, soluble, 5.37; reverted, 3.84; insoluble, 1.79; total, 11; available, 9.21; nitrogen, 2.52; potash, 4.39; availability of nitrogen, 93; chlorine, 1.5.

Remark: Source of potash equivalent to manure salts.

6113. Zell's Economizer Phosphate, Exchange Mill Co., Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen from animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 5.12; reverted, 3.52; insoluble, 1.24; total, 9.88; available, 8.64; nitrogen, 1.09; potash, 2.42; availability of nitrogen, 77; chlorine, 3.7.

Remark: Chlorine excessive.

6227. Zell's Ammoniated Bone Super-Phosphate, R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 1.65; potash, 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen from animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 5.30; reverted, 3.69; insoluble, 1.64; total, 10.63; available, 8.99; nitrogen, 1.88; potash, 2.61; availability of nitrogen, 84; chlorine, 2.9.

THE ARMOUR FERTILIZER WORKS,

Baltimore, Md., and Buena Vista, Virginia.

6032. Grain Grower, Myne & Green, Agent, Hurricane, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 2; total, 10; available, 8; nitrogen, 1.65; potash, 2; phosphoric acid from animal bone and acid phosphate; nitrogen, 1-10 to 2-10 bone, 8-10 to 9-10 bone tankage; potash, 1/5 to 2/5 muriate, 3/5 to 4/5 kainit. Found: Phosphoric acid, soluble, 4.41; reverted, 3.89; insoluble, 0.87; total, 9.17; available, 8.30; nitrogen, 1.69; potash, 2.29; availability of nitrogen, 93; chlorine, 3.6.

Remark: Source of potash equivalent to kainit. Chlorine excessive.

6105. Grain Grower, R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 4.99; reverted, 3.01; insoluble, 0.51; total, 8.51; available, 8; nitrogen, 1.48; potash, 2.23; availability of nitrogen, 83; chlorine, 3.2.

Remark: Source of potash equivalent to kainit. Nitrogen low. Chlorine excessive.

6061. Royal Ammoniated Bone, E. R. Judy, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 2; total, 10; available, 8; nitrogen, 0.82; potash, 4; phosphoric acid from acid phosphate and animal bone, nitrogen, ⅕ to ⅗ from bone; ⅖ to ⅘ bone tankage; potash, ⅓ to ⅔ from kainit; ⅓ to ⅔ from muriate. Found: Phosphoric acid, soluble, 5.21; reverted, 3.73; insoluble, 1.42; total, 10.36; available, 8.94; nitrogen, 0.69; potash, 4.96; availability of nitrogen, 71; chlorine, 2.3.

Remark: Nitrogen low.

6210. Royal Ammoniated Bone. R. N. Stewart & Son, Aegnt, Martinsburg, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 5.63; reverted, 2.36; insoluble, 0.68; total, 8.67; available, 7.99; nitrogen, 0.84; potash, 4.08; availability of nitrogen, 74; chlorine, 1.9.

6106. Phosphate and Potash, No. 1, R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 2; total, 12; available, 10; potash, 2; phosphoric acid from acid phosphate, potash, ⅕ to⅖ from muriate; ⅗ to ⅘ kainit. Found: Phosphoric acid, soluble, 6.86; reverted, 2.37; insoluble, 0.84; total, 10.07; available, 9.23; potash, 2.16; chlorine, 3.2.

Remark: Phosphoric acid low. Source of potash equivalent to kainit.

6107. Phosphate and Potash, No. 2, R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8;

potash, 5; phosphoric acid from acid phosphate; potash, ⅖ to ⅗ muriate of potash; ⅖ to ⅗ kainit. Found: Phosphoric acid, soluble, 5.16; reverted, 2.70; insoluble, 0.60; total, 8.46; available, 7.86; potash, 4.79; chlorine, 3.2.

Remark: Source of potash equivalent to kainit. Chlorine excessive.

6108. Star Phosphate, R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 2; total, 16; available, 14; phosphoric acid from acid phosphate. Found: Phosphoric acid, soluble, 12.84; reverted, 2.22; insoluble, 0.15; total, 15.21; available, 15.06.

6013. Star Phosphate, submitted for analysis by J. D. Bowman, Hoult, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 13.34; reverted, 1.98; insoluble, 0.47; total, 15.79; available, 15.32.

6153. Star Phosphate, W. H. Bailey Hardware Co., Agent, Morgantown, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 13.30; reverted, 2.33: insoluble, 0.26; total, 15.89; available, 15.63.

6157. Phosphate and Potash, No. 2, W. H. Bailey Hardware Co., Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; potash, 5; phosphoric acid from acid phosphate, potash, ⅖ to ⅗ from kainit; ⅖ to ⅗ muriate. Found: Phosphoric acid, soluble, 5.04; reverted, 3.75; insoluble, 0.70: total, 9.49; available, 8.79; potash, 5.03; chlorine, 3.

Remark: Source of potash equivalent to kainit.

6202. Wheat Special, Geo. B. Hooff, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble, 6: reverted, 2; insoluble, 2; total, 10; available, 8; nitrogen, 0.82;

potash, 2; phosphoric acid from acid phosphate and animal bone, nitrogen, ⅕ to ⅖ bone; ⅗ to ⅘ bone tankage; potash from kainit. Found: Phosphoric acid, soluble, 6.04; reverted, 2.78; insoluble, 0.65; total, 9.47; available, 8.82; nitrogen, 0.72; potash, 2.03; availability of nitrogen, 72; chlorine, 3.3.

Remark: Nitrogen low. Source of potash equivalent to kainit. Chlorine excessive.

6230. Bone Meal, Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, total, 24; nitrogen, 2.47; phosphoric acid from animal bone, nitrogen from bone. Found: Phosphoric acid, total, 24.60; nitrogen, 2.43; availability of nitrogen, 89.

6014. Muriate of Potash, submitted for analysis by J. D. Bowman, Hoult, W. Va. Found: Potash, 48; chlorine, 0.9.

BAUGH & SONS CO.,

Philadelphia, Pa., and Norfolk, Va.

6025. Baugh's Excelsior Guano, West Virginia Implement Co., Agent, Elkins, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 0.823; potash, 4; phosphoric acid from phosphate rock; nitrogen, ½ from animal tankage; ½ from garbage tankage; potash, ½ from muriate of potash; ½ from kainit. Found: Phosphoric acid, soluble, 6.17; reverted, 3.59; insoluble, 0.79; total, 10.55; available, 9.76; nitrogen, 1.30; potash, 4.49; availability of nitrogen, 80; chlorine, 1.9.

6094. Baugh's Excelsior Guano, Dean & Reeves, Fairmont, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.42; reverted, 5.13; insoluble, 1.30; total, 9.85; available, 8.55; nitrogen, 1.03; potash, 4.97; availability of nitrogen, 68; chlorine, 2.2.

Remark: Chlorine excessive.

6026. Baugh's Special Potato Manure, West Virginia Implement Co., Agent, Elkins, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 7; available, 5; nitrogen, 1.65; potash, 10; phosphoric acid from phosphate rock; nitrogen, ½ from animal tankage; ½ from sulphate of ammonia; potash from muriate of potash. Found: Phosphoric acid, soluble, 2.79; reverted, 3.09; insoluble, 0.52; total, 6.40; available, 5.88; nitrogen, 1.94; potash, 10.98; availability of nitrogen, 91; chlorine, 1.5.

Remark: Source of potash equivalent to manure salts.

6068. Baugh's Special Potato Manure, N. C. Musgrave, Agent, Grafton, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 4; reverted, 1.51; insoluble, 0.45; total, 5.96; available, 5.51; nitrogen, 1.83; potash, 10.80 availability of nitrogen, 90; chlorine, 1.6.

Remark: Source of potash equivalent to manure salts.

6095. Baughs' Special Potato Manure, Dean & Reeves, Agent, Fairmont, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble 4,27; reverted, 1.37; insoluble, 0.54; total, 6.18; available, 5.64; nitrogen, 1.72; potash, 10.41; availability of nitrogen, 91; chlorine, 1.5.

Remark: Source of potash equivalent to manure salts.

6027. Baugh's Export Bone with Potash, West Virginia Implement Co., Agent, Elkins, W. Va. Guarantee: Phosphoric acid, total, 11; nitrogen, 1.65; potash, 2; phosphoric acid from animal bone; nitrogen from animal bone; potash, ½ from muriate, ½ from kainit. Found: Phosphoric acid, total, 11.78; nitrogen, 1.89; potash, 3.18; availability of nitrogen, 95; chlorine, 3.9.

Remark: Source of potash equivalent to kainit. Chlorine excessive.

6111. Baugh's Export Bone with Potash, T. B. Licklider, Agent, Martinsburg, W. Va. Guarantee: (As above).

Found: Phosphoric acid, total, 12.72; nitrogen, 2.29; potash, 2.13; availability of nitrogen, 95; chlorine, 3.5.

Remark: Source of potash equivalent to kainit. Chlorine excessive.

6045. Baugh's High Grade Acid Phosphate, Philippi Mill Co., Agent, Philippi, W. Va. Guarantee: Phosphoric acid, insoluble, 1; total, 15; available, 14; phosphoric acid from dissolved rock. Found: Phosphoric acid, soluble, 13.15; reverted, 1.93: insoluble, 0.19; total, 15.27; available, 15.08.

6073. Baugh's High Grade Acid Phosphate, Offutt & Lakin, Terra Alta, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 9.49; reverted, 5.72; insoluble, 0.61; total, 15.82; available, 15.21.

6047. Baugh's 12 & 5, Philippi Mill Co., Agent, Philippi, W. Va. Guarantee: Phosphoric acid, available, 12; potash, 5; phosphoric acid from dissolved rock; potash, ½ from muriate of potash, ½ from kainit. Found: Phosphoric acid, soluble, 6.32; reverted, 5.62; insoluble, 0.78; total, 12.72; available, 11.94; potash, 4.89; chlorine, 1.5.

6046. Baugh's Soluble Alkaline, Philippi Mill Co., Agent, Philippi, W. Va. Guarantee: Insoluble, 1; total, 11; available, 10; potash, 2; phosphoric acid from dissolved rock; potash from kainit. Found: Phosphoric acid, soluble, 1.19; reverted, 8.93; insoluble, 0.91; total, 11.03; available, 10.12; potash, 2.36; chlorine, 3.4.

Remark: Chlorine excessive.

6074. Baugh's Soluble Alkaline, Offutt & Lakin, Agent, Terra Alta, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 0.92; reverted, 9.08; insoluble, 1.30; total, 11.30: available, 10: potash, 2.32: chlorine, 2.9.

6065. Baugh's Animal Bone and Potash Compound, (for all crops), Conoway & Clayton, Agents, Barracksville, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 1.65; potash, 2; phosphoric acid from phosphate rock; nitrogen, ⅔ from animal tankage, ⅓ from sulphate of amonia; potash, ½ from muriate of potash, ½ from kainit. Found: Phosphoric acid, soluble, 5.63; reverted, 3.78; insoluble, 1.14; total, 10.55; available, 9.41; nitrogen, 1.98; potash, 2.51; availability of nitrogen, 83; chlorine, 2.8.

Remark: Source of potash equivalent to kainit.

6066. Baugh's Potato and Truck Special, Conoway & Clayton, Agent, Barracksville, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 9; available, 7; nitrogen, 2.88; potash, 7; phosphoric acid from phosphate rock; nitrogen, ½ from animal tankage, ½ from sulphate of ammonia; potash from muriate of potash. Found: Phosphoric acid, soluble, 6.37; reverted, 1.61; insoluble, 0.32; total, 8.30; available, 7.98; nitrogen, 3.41; potash, 6.04; availability of nitrogen, 95; chlorine, 1.8.

Remark: Potash low. Source of potash equivalent to manure salts.

6093. Baugh's Potato and Truck Special, Dean & Reeves, Agent, Fairmont, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 5.01; reverted, 3.13; insoluble, 0.97; total, 9.11; available, 8.14; nitrogen, 2.90; potash, 7.82; availability of nitrogen, 94; chlorine, 1.2.

Remark: Chlorine excessive.

6067. Baugh's Double Eagle $25 Phosphate Raw Bone Super Phosphate, N. C. Musgrave, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 1.65; potash, 1; phosphoric acid from Phosphate rock; nitrogen, ⅔ from animal tankage, ⅓ from sulphate of ammonia; potash from kainit. Found: Phosphoric acid, soluble, 4.68; reverted, 4.81; insoluble, 1.23; total, 10.72; available, 9.49; nitrogen, 1.77; potash, 1.50; availability of nitrogen, 85; chlorine, 3.

6109. Baugh's Complete Animal Bone Fertilizer, T. P. Licklider, Martinsburg, W. Va. Guarantee: Phosphoric acid, available, 8; nitrogen, 1.65; potash, 5; phosphoric acid from phosphate rock; nitrogen, ⅔ from animal tankage, ⅓ sulphate of ammonia; potash, ½ from muriate of potash, ½ from kainit. Found: Phosphoric acid, soluble, 4.18; reverted, 4.20; insoluble, 0.61; total, 8.99; available, 8.38; nitrogen, 1.88; potash, 4.80; availability of nitrogen, 92; chlorine, 1.6.

6110. Baugh's General Crop Grower, T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 0.823; potash, 1; phosphoric acid from phosphate rock; nitrogen, ½ from animal tankage, ½ from garbage tankage; potash from kainit. Found: Phosphoric acid, soluble, 4.22; reverted, 4.42; insoluble, 1.48; total, 10.12; available, 8.64; nitrogen, 1.16; potash, 1.35; availability of nitrogen, 77; chlorine, 2.8.

6112. Baugh's Pure Dissolved Animal Bones. T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, insoluble, 3; total, 16; available, 13; nitrogen, 2.06; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, soluble, 7.02; reverted, 9.27; insoluble, 0.81; total, 17.10; available, 16.29; nitrogen, 2.20; availability of nitrogen, 90.

6200. Special Mixture, G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 1.02; potash, 1.25; phosphoric acid from phosphate rock; nitrogen, ⅔ from animal tankage, ⅓ sulphate of ammonia: potash, ½ from muriate of potash, ½ from kainit. Found: Phosphoric acid, soluble 4.17: reverted

7.20; insoluble, 2.48; total, 13.85; available, 11.37; nitrogen, 1.36; potash, 4.24; availability of nitrogen, 79; chlorine, 2.9.

Remark: Chlorine excessive.

6201. Long's Special Mixture, L. M. Long, Agent, Rippon, W. Va. Guarantee: Phosphoric acid, available, 13; nitrogen, 1.23; potash, 2.50; phosphoric acid from phosphate rock; nitrogen, ⅓ from dissolved animal bone, ⅓ blood, ⅓ animal tankage; potash from muriate of potash. Found: Phosphoric acid, soluble, 10.39; reverted, 3.61; insoluble, 1.20; total, 15.20; available, 14; nitrogen, 1.35; potash, 2.84; availability of nitrogen, 91; chlorine, 0.8.

6218. Baugh's Ammoniated Soluble Alkaline, G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 0.41; potash, 2; phosphoric acid from phosphate rock; nitrogen from garbage tankage; potash, ½ from kainit, ½ muriate of potash. Found: Phosphoric acid, soluble, 2.87; reverted, 5.55; insoluble, 1.10; total, 9.52; available, 8.42; nitrogen, 0.49; potash, 3.06; availability of nitrogen, 50; chlorine, 2.9.

Remark: Source of potash equivalent to kainit.

6219. Baugh's Wheat Fertilizer, Conoway & Clayton. Agent, Barracksville, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 1.65; potash, 2; phosphoric acid from phosphate rock: nitrogen, ⅔ from animal tankage, ⅓ sulphate of ammonia; potash, ½ muriate of potash, ½ kainit. Found: Phosphoric acid, soluble, 3.22; reverted, 6.06, insoluble, 1.65; total, 10.93; available, 9.28; nitrogen, 2.16: potash, 2.62; availability of nitrogen, 89; chlorine, 2.6.

Remark: Source of potash equivalent to kainit.

BOWKER FERTILIZER COMPANY.

Boston, New York and Cincinnati.

6085. Bowker's Bone Meal, T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, total, 25; nitrogen, 1.23; phosphoric acid from bone; nitrogen from bone. Found: Phosphoric acid, total, 27.20; nitrogen, 1.36; availability of nitrogen, 92.

6090. Bowker's Bone Meal, Orie Myers, Agent, Clarksburg, W. Va. Guarantee: (As above). Found: Phosphoric acid, total, 21.79; nitrogen, 1.53; availability of nitrogen, 88.

Remark: Phosphoric acid low.

6086. Bowker's Dissolved Bone and Potash, T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 12; available, 10; potash, 2; phosphoric acid from phosphate rock; potash from muriate. Found: Phosphoric acid, soluble, 6.08; reverted, 5.03; insoluble, 3.65; total, 14.76; available, 11.11; potash, 2.73; chlorine, 1.

6088. Bowker's 10 percent Manure, Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 7; available, 5; nitrogen, 0.82; potash, 10; phosphoric acid from phosphate rock; potash from muriate; nitrogen from animal tankage. Found: Phosphoric acid, soluble, 2.96; reverted, 3.43; insoluble, 2.14; total, 8.53; available, 6.39; nitrogen, 0.81; potash, 11.45; chlorine, 9; availability of nitrogen, 76.

6089. Bowker's Harvest Bone, Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 0.82; potash, 1; phosphoric acid from phosphate rock; nitrogen from animal tankage;

potash from muriate. Found: Phosphoric acid, soluble, 4.25; reverted, 4.96; insoluble, 2.47; total, 11.68; available, 9.21; nitrogen, 0.96; potash, 1.21; availability of nitrogen, 75; chlorine, .7.

6124. Bowker's Harvest Bone, J. M. Miller & Bro,. Agent, Ronceverte, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 4.44; reverted, 4.64; insoluble, 2.24; total, 11.32; available, 9.08; nitrogen, 1.06; potash, 1.09; availability of nitrogen, 82; chlorine, .9.

6159. Bowker's Harvest Bone, W. F. Sill, Agent, Pennsboro, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 4.71; reverted, 5.65; insoluble, 2.87; total, 13.23; available, 10.36; nitrogen, 0.94; potash, 1.07; availability of nitrogen, 78; chlorine, .8.

6160. Bowker's Soluble Bone, W. F. Sill, Agent, Pennsboro, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 16; available, 14; phosphoric acid from phosphate rock. Found: Phosphoric acid, soluble, 13.05; reverted, 3.67; insoluble, 2.06; total, 18.78; available, 16.72.

6231. Bowker's Soluble Bone, W. F. Sill, Agent, Pennsboro, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 13.53; reverted, 3.67; insoluble, 0.91; total, 18.11; available, 17.20.

BALTIMORE PULVERIZING CO.,

Baltimore, Maryland.

6214. Special Fall Mixture, R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, insoluble, 1; total, 9; available, 8; potash, 1; phosphoric acid from Florida dissolved bone phosphate; potash from sulphate of potash. Found: Phosphoric acid, soluble, 0.92; reverted, 7.83; insoluble, 1.02; total, 9.77; available, 8.75; potash, 1.75; chlorine, 2.6.

Remark: Source of potash equivalent to kainit.

GRIFFITH & BOYD COMPANY,

Baltimore, Maryland.

6100. XX Potash Manure, T. P. Licklider, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 3; insoluble, 1; total, 11; available, 10; potash, 5; phosphoric acid from S. C. rock; potash, ½ from muriate of potash, ½ kainit. Found: Phosphoric acid, soluble, 4.30; reverted, 6.29; insoluble, 2.10; total, 12.69; available, 10.59; potash, 4.83; chlorine, 1.6.

6142. XX Potash Manure, R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 4.58; reverted, 7.20; insoluble, 2.39; total, 14.17; available, 11.78; potash, 4.82; chlorine, 1.6.

6133. High Grade Acid Phosphate, R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from S. C. rock. Found: Phosphoric acid, soluble, 13.41; reverted, 3.35; insoluble, 0.74; total, 17.50; available, 16.76.

6140. Valley Fertilizer, R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble, 6 reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.41; potash, 3; phosphoric acid, 1-10 from fish tankage, 9-10 from rock; nitrogen, ½ from garbage tankage; ½ fish; potash, ⅓ from muriate of potash, ⅔ from kainit. Found: Phosphoric acid, soluble, 6.50; reverted, 2.39; insoluble, 0.86; total, 9.75; available, 8.99; nitrogen, 0.51; potash, 2.92; availability of nitrogen, 69; chlorine, 2.7.

Remark: Source of potash equivalent to kainit.

THE HUBBARD FERTILIZER COMPANY,

Baltimore, Maryland.

6182. Hubbard's Soluble Bone Phosphate, submitted for analysis by M. W. Burr, Bardman, W. Va. Guarantee: Phosphoric acid, soluble, 11; reverted, 5; insoluble, 1; total, 17; available, 16; phosphoric acid from high grade Florida phosphate. Found: Phosphoric acid, soluble, 15.66; reverted, 0.58; insoluble, 0.24; total, 16.48; available, 16.24.

6183. Hubbard's Dissolved Animal Bone & Potash, Parley DeBerry, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 3; insoluble, 1; total, 9; available, 8; nitrogen, 1; potash, 2; phosphoric acid, ⅗ from high grade Florida phosphate, ⅕ from tankage, ⅕ from dissolved animal bone; nitrogen, ½ bone tankage; ½ blood and animal matter; potash, ½ from sylvanit, ½ from kainit. Found: Phosphoric acid, soluble, 6.52; reverted, 1.74; insoluble, 1.83; total, 10.09; available, 8.26; nitrogen, 1.06 potash, 2.65; availability of nitrogen, 86; chlorine, 2.4.

6216. Hubbard's Soluble Bone Phosphate, G. T. Hodges, Shepherdstown, W. Va. Guarantee: Phosphoric acid, soluble, 11; reverted, 5; insoluble, 1; total, 17; available, 16; phosphoric acid from high grade Florida phosphate. Found: Phosphoric acid, soluble, 15.25; reverted, 2.52; insoluble, 0.84; total, 18.61; available, 17.77.

6217. Hubbard's Alkaline, G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid, soluble, 7.50; reverted, 4.50; insoluble, 1; total, 13; available, 12; potash, 3; phosphoric acid from high grade Florida phosphate; potash from sylvanit. Found: Phosphoric acid, soluble, 6.73; reverted, 5.10; insoluble, 0.99; total, 13.82; available, 12.83; potash, 5.42; chlorine, 1.3.

6232. Hubbard's Columbia Gem Phosphate, C. E. Casler, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 3; insoluble, 1; total, 9; available, 8; nitrogen, 0.41; potash, 1; phosphoric acid, ⅗ from high grade Florida phosphate, 1-5 from tankage, 1-5 from dissolved animal bone; nitrogen, ½ from bone tankage, ½ from blood and animal matter; potash, ½ from sylvanit, ½ from kainit. Found: Phosphoric acid, soluble, 2.81; reverted, 6.68; insoluble, 2.88; total, 12.37; available, 9.49; nitrogen, 0.89; potash, 1.94, availability of nitrogen, 80; chlorine, 2.6.

6233. Hubbard's Oriental Phosphate, G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid, soluble, 5; ;reverted, 3; insoluble, 1; total, 9; available, 8: nitrogen, 1; potash, 1; phosphoric acid, ⅗ from high grade Florida phosphate, 1-5 from tankage, 1-5 from dissolved animal bone; nitrogen, ½ from bone tankage, ½ blood and animal matter; potash, ½ from sylvanit, ½ from kainit. Found: Phosphoric acid, soluble, 8.21; reverted, 2.25; insoluble, 1.45; total, 11.91; available, 10.46; nitrogen, 0.83; potash, 1.86; availability of nitrogen, 82; chlorine, 2.6.

Remark: Nitrogen low.

THE JARECKI CHEMICAL COMPANY

Station P., Cincinnati, Ohio.

6029. No. 1 Fish Guano, Harbour & Burdett. Agent, Hurricane, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 1; potash, 2; phosphoric acid from mineral phosphate, bone and animal tankage; nitrogen from animal tankage; potash from muriate: Found: Phosphoric acid, soluble, 5.77; reverted, 2.48; insoluble, 1.65; total, 9.90; available, 8.25; nitrogen, 1.13; potash, 2.24; availability of nitrogen, 71; chlorine, 1.3.

Remark: Chlorine excessive.

6031. No. 1. Fish Guano, The Damron Feed & Seed Co.. Agent, Huntington, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 5.68; reverted, 3.37; insoluble, 1.80; total, 10.85; available, 9.05; nitrogen, 1.12; potash, 2.27; availability of nitrogen, 71; chlorine, 1.3.

Remark: Chlorine excessive.

6115. No. 1 Fish Guano, J. M. Rodgers, Agent, Ronceverte, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 5.37; reverted, 3.22; insoluble, 1.65; total, 10.14; availalbe, 8.49; nitrogen, 1.12; potash, 1.91; availability of nitrogen, 75; chloride, 1.6.

Remark: Chlorine excessive.

6030. Fish & Potash, Tobacco & Potato Food, Harbour & Burdett, Agent, Hurricane, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 4; phosphoric acid from mineral phosphate, bone and animal tankage; nitrogen from animal tankage; potash from muriate. Found: Phosphoric acid, soluble, 5.31; reverted, 2.64; insoluble, 1.73; total, 9.68; available, 7.95; nitrogen, 0.90; potash, 4.71; availability of nitrogen, 73; chlorine, 1.4.

Remark: Chlorine equivalent to manure salts.

THE MARIETTA BONE & PHOSPHATE COMPANY,

Marietta, Ohio.

6149. "Horse Brand" Potato & Truck Special, C. F. Braumlick & Co., Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, total, 10; available, 8; nitrogen, 2.50; potash, 5; phosphoric acid, ¼ from tankage, ¾ from acid phosphate; nitrogen, ½ from bone tankage, ½ from nitrate of soda; potash from muriate. Found: Phosphoric acid, soluble, 2.35; reverted, 7.51; insoluble, 2.14; total, 12; available, 9.86; nitrogen, 1.34; potash, 4.93; availability of nitrogen, 89; chlorine, .9.

Remark: Nitrogen low.

6156. "Horse Brand" Potato & Truck Special, Walter Marshall, Agent, Wheeling, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 3.97; reverted, 5.92; insoluble, 1.04; total, 10.93; available, 9.89; nitrogen, 1.32; potash, 3.44; availability of nitrogen, 90; chlorine, .9.

Remark: Nitrogen low. Potash low.

6155. "Horse Brand" Raw Bone, Walter Marshall, Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, total, 20; nitrogen, 4; phosphoric acid from raw bone; nitrogen from raw bone. Found: Phosphoric acid, total, 21.24; nitrogen, 3.30; availability of nitrogen, 79.

Remark: Nitrogen low.

6143. "Horse Brand" Acid Phosphate, C. F. Braumlick, Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, total, 12; available, 10; phosphoric acid from acid phosphate. Found: Phosphoric acid, soluble, 6.73; reverted, 3.95; insoluble, 0.45; total, 11.13; available, 10.68.

D. B. MARTIN COMPANY,

Philadelphia, Norfolk & Richmond.

6194. Martin's Pure Raw Bone Meal, "Bull Head," Washington, Alexander & Cooke, Charlestown, W. Va. Guarantee: Phosphoric acid, total, 22; nitrogen, 3.71; phosphoric acid from pure raw bone; nitrogen from pure raw bone. Found: Phosphoric acid, total, 21.70; nitrogen, 4.03, availability of nitrogen, 79.

Remark: Phosphoric acid low.

THE NEW PROCESS FERTILIZER COMPANY.

Columbus, Ohio.

6051. Humus Chief, M. T. Thurston, Agent, Charleston, W. Va. Guarantee: Phosphoric acid, total, 15; available, 14; phosphoric acid from phosphate rock and tankage. Found: Phosphoric acid, soluble, 8.34; reverted, 5.44; insoluble, 2.03; total, 15.81; available, 13.78.

6052. O. K. Chief, M. T. Thurston, Agent, Charleston, W. Va. Guarantee: Phosphoric acid, total, 8; available, 7; nitrogen, 1.35; potash, 2; phosphoric acid from phosphate rock and tankage, nitrogen from garbage tankage, potash from muriate. Found: Phosphoric acid, soluble, 4.43; reverted, 3.63; insoluble, 1.16; total, 9.22; available, 8.06; nitrogen, 1.61; potash, 2.51; availability of nitrogen, 65; chlorine, 1.2.

6053. Little Chief, M. T. Thurston, Agent, Charleston, W. Va. Guarantee: Phosphoric acid, total, 12; available, 10; potash, 3; phosphoric acid from phosphate rock and tankage, potash from muriate. Found: Phosphoric acid, soluble, 6.14; reverted, 3.66; insoluble, 1.36; total, 11.16; available, 9.70; potash, 2.91; chlorine, 1.5.

Remark: Phosphoric acid low. Chlorine excessive.

G. OBER & SONS COMPANY,

Baltimore, Maryland.

6174. Ober's Farmer's Mixture, Standard Hardware Co., Agent, Weston, W. Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 2; insoluble, 1; total, 10; available, 9; nitrogen, 0.82; potash, 2; phosphoric acid from high grade Florida phosphate, 8-9; bone from tankage and fish, 1-9; nitrogen from high grade bone and blood tankage, ½ to ¾; fish, ½ to ¾. Potash from sulphate of potash. Found: Phosphoric acid, soluble, 8.90; reverted, 1.66; insoluble, 0.49; total 11.05; available, 10.56; nitrogen, 1.13; potash, 2.57; availability of nitrogen, 90; chlorine, 2.4.

Remark: Source of potash equivalent to manure salts. Chlorine excessive.

6181. Ober's High Grade Acid Phosphate, sent in for analysis by M. W. Burr, Bardman, W. Va. Guarantee: Phosphoric acid, soluble, 14.50; reverted, 1.50; insoluble, 1; total, 17; available, 16; phosphoric acid from high grade Florida phosphate. Found: Phosphoric acid, soluble, 14.53; reverted, 2.34; insoluble, 0.40; total, 17.27; available, 16.87.

6213. S. & S. Special Wheat Compound, R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 2; insoluble, 2; total, 11; available,

6163. Piedmont High Grade S. C. Bone, Bishop & Barbe, Agent, Jane Lew , W. Va. Guarantee: Phosphoric acid, insoluble, 1; total, 15; available, 14; phosphoric acid from S. C. rock. Found: Phosphoric acid, soluble, 12.13; reverted, 2.10; insoluble, 0.21; total, 14.44; available, 14.23.

6221. Piedmont High Grade S. C. Bone, Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 10.80; reverted, 2.56; insoluble, 0.35; total, 13.71; available, 13.36.

Remark: Phosphoric acid low.

6166. Piedmont Potato Producer, J. A. Mason & Co., Agent, Mannington, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 7; available, 5; nitrogen, 2.09; potash, 6; phosphoric acid from dissolved bone and phosphate rock; nitrogen, ⅓ from bone tankage, ⅓ nitrate of soda and ⅓ blood; potash from high grade muriate of potash. Found: Phosphoric acid, soluble, 6.09; reverted, 0.17; insoluble, 0.41; total, 6.67; available, 6.26; nitrogen, 2; potash, 5.50; availability of nitrogen, 87; chlorine, .9.

Remark: Potash low.

6168. Levering's Harvest Queen, Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, insoluble, 2; total, 10; available, 8; nitrogen, 0.82; potash, 2; phosphoric acid from dissolved phosphate rock and dissolved bone tankage; nitrogen, ½ from blood and ½ bone tankage; potash, ½ from muriate of potash, ½ kainit. Found: Phosphoric acid, soluble, 7.19; reverted, 1.19; insoluble, 0.64; total, 9.02; available, 8.38; nitrogen, 1.22; potash, 2.60; availability of nitrogen, 73; chlorine, 1.7.

6173. General Crop Grower, J. A. Mason & Co., Agent, Mannington, W. Va. Guarantee: Phosphoric acid, available, 8; nitrogen, 0.82; potash, 1; phosphoric acid from bone phosphate; nitrogen, ½ from blood and ½ from bone tankage; potash, ½ from muriate of potash, ½ kainit. Found: Phosphoric acid, soluble, 6.60; reverted, 1.70; insoluble, 0.58; total, 8.88; available, 8.30; nitrogen, 0.94; potash, 2.02; availability of nitrogen, 67; chlorine, 1.7.

6220. General Crop Grower, Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 6.10; reverted, 3.42; insoluble, 0.69; total, 10.21; available, 9.52; nitrogen, 0.85; potash, 1.58; availability of nitrogen, 76; chlorine, 2.4.

Remark: Chlorine excessive.

6222. Pure Raw Bone Meal, G. W. Niswander & Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid total, 23; nitrogen, 3.70; phosphoric acid from bone; nitrogen from raw bone. Found: Phosphoric acid, total, 23.73; nitrogen, 3.80; availability of nitrogen, 64.

6223. Piedmont Pure Raw Bone Mixture, G. W. Niswander & Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, insoluble, 4; total, 12; available, 8; nitrogen, 1.02; potash, 2; phosphoric acid from dissolved bone tankage; nitrogen from bone tankage; potash, ½ from muriate, ½ kainit. Found: Phosphoric acid, soluble, 5.99; reverted, 4.76; insoluble, 2.99; total, 13.74; available, 10.75; nitrogen, 1.27; potash, 3.31; availability of nitrogen, 86; chlorine, 3.3.

Remark: Source of potash equivalent to kainit. Chlorine excessive.

6161. Piedmont Economy, Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, available, 10; nitrogen, 0.20; potash, 2; phosphoric acid from mineral phosphate; nitrogen, ½ from bone tankage, ½ blood; potash, ½ from muriate, ½ kainit. Found: Phosphoric acid, soluble, 6.70; reverted, 2.62; insoluble, 0.20; total, 9.52; available, 9.32; nitrogen, 0.32; potash, 1.96; availability of nitrogen, 70; chlorine, 2.3.

Remark: Phosphoric acid low. Chlorine excessive.

RAISIN MONUMENTAL COMPANY,

Baltimore, Maryland.

6028. Special Formulae for Corn & Buckwheat, A. P. Russell & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble, 4; reverted, 2; insoluble, 1; total, 7; available, 6; potash, 3; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; potash, ½ to ¾ from high grade muriate of potash, ¼ to ½ genuine German kainit. Found: Phosphoric acid, soluble, 5.45; reverted, 2.88; insoluble, 1.41; total, 9.74; available, 8.33; potash, 3.63; chlorine, 1.4.

6069. Acid Phosphate, C. W. Mayers & Son, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1; total, 15; available, 14; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates. Found: Phosphoric acid, soluble, 10.68; reverted, 4.11; insoluble, 1.75; total, 16.54; available, 14.79.

6154. Acid Phosphate, W. H. Bailey Hardware Co., Agent, Morgantown, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 10|72; reverted, 5.39; insoluble, 1.52; total, 17.63; available, 16.11.

6070. Dissolved Bone, C. W. Mayer & Son, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; nitrogen, 1.65; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; nitrogen, ¼ to ⅔ dissolved pure animal bone, ¼ to ⅓ high grade tankage. Found: Phosphoric acid, soluble, 6.75; reverted, 5.26; insoluble, 3.01; total, 15.02; available, 12.01; nitrogen, 1.91; availability of nitrogen, 88.

6071. Special Bone & Potash, C. W. Mayer & Son, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 5; phosphoric acid from high grade Charleston Florida and Tennessee phosphates; potash, ½ to ¾ from high grade muriate of potash, , ¼ to ½ genuine German kainit. Found: Phosphoric acid, soluble, 4.78; reverted, 5.83; insoluble, 1.65; total, 12.26; available, 10.61; potash, 5.83; chlorine, 1.4.

6072. Bone & Potash, C. W. Mayer & Son, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 2; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; potash, ½ to ¾ from high grade muriate of potash, ¼ to ¾ German kainit. Found: Phosphoric acid, soluble, 6.96; reverted, 3.63; insoluble, 1.38; total, 11.97; available, 10.59; potash, 2.97; chlorine, 1.4.

6091. William Penn Crop Grower, A. P. Russell & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid. soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 1; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; nitrogen, ⅕ to ¼ from high grade fish, ⅓ to ½ high grade tankage, ⅙ to ⅕ blood, ⅙ to ⅕ high grade sulphate of ammonia; potash, ½ to ⅔ from high grade muriate of potash, ⅓ to ½ genuine German kainit. Found: Phosphoric acid, soluble, 2.44; reverted, 6.40; insoluble, 4.31; total, 13.15; available, 8.84; nitrogen, 1.09; potash, 1.25; availability of nitrogen, 72; chlorine, .7.

6092. Irish Potato Special, A. P. Russell & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 2; insoluble, 1; total, 8; available, 7; nitrogen, 3.29; potash, 8; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; nitrogen, ¼ to ½ from high grade fish, ¼ to ½ high grade tankage, ¼ to ½ sulphate of ammonia; potash, 9-10 from high grade sulphate of potash, 1-10 from muriate of potash. Found: Phosphoric acid, soluble, 5.81; reverted, 2.17; insoluble, 1.41; total, 9.39; available, 7.98; nitrogen, 3.57; potash, 9.56; availability of nitrogen, 86; chlorine, 0.05.

6158. XXX Fertilizer, W. H. Bailey Hardware Co., Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 1.65; potash, 5; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; nitrogen, 1/5 to 1/4 high grade fish, 1/3 to 1/2 high grade tankage; 1/6 to 1-5 blood, 1/6 to 1-5 high grade sulphate of ammonia; potash, 1/2 to 2/3 high grade muriate of potash, 1/3 to 1/2 genuine German kainit. Found: Phosphoric acid, soluble, 5.42; reverted, 3.44; insoluble, 2.30; total, 11.16; available, 8.86; nitrogen, 1.58; potash, 5.06 availability of nitrogen, 79; chlorine, .9.

6175. Wheat, Corn and Oats Mixture, W. H. Bailey Hardware Co., Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.41; potash, 2; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; nitrogen, 1-5 to 1/4 high grade fish. 1/3 to 1/2 high grade tankage, 1/6 to 1-5 blood, 1/6 to 1-5 high grade sulphate of ammonia; potash, 1/2 to 2/3 from genuine German kainit, 1/3 to 1/2 high grade muriate of potash. Found: Phosphoric acid, soluble, 1.30; reverted, 6.52; insoluble, 2.62; total, 10.44; available, 7.82; nitrogen, 0.52; potash, 2.25; availability of nitrogen, 70; chlorine, 2.4.

6184. Best Wheat and Grass Producer, C. W. Mayer & Sons, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 1.23; potash, 3; phosphoric acid from high grade Charlseton, Florida and Tennessee phosphates; nitrogen, 1/5 to 1/4 from high grade fish, 1/3 to 1/2 high grade tankage. 1/6 to 1/5 blood, 1/6 to1-5 high, grade sulphate of ammonia;

potash, ½ to ⅔ from high grade muriate of potash, ⅓ to ½ genuine German kaint. Found: Phosphoric acid, soluble, 6.60; reverted, 2.11; insoluble, 2.46; total, 11.17; available, 8.71; nitrogen, 1.31; potash, 3.35; availability of nitroegn, 81; chlorine, 1.

6185. Seawall Special, Geo. Carskadon, Agent, Keyser, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; phosphoric acid from high grade Charleston, Florida and Tennessee Phosphates; Found: Phosphoric acid, soluble, 9.06; reverted, 2.48; insolible, 0.84; total, 12.38; available, 11.54.

6128. Washington, Alexander & Cooke's Regular Corn Mixture, Washington, Alexander & Cook, Agent, Charleston, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total 11; available, 10; potash, 3; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates: potash, ⅓ to ½ from high grade muriate of potash, ⅓ to ½ from genuine German kainit. Found: Phosphoric acid, soluble, 1.92; reverted, 8.08; insoluble, 2.56; total, 12.56; available, 10; potash, 3.48; chlorine, 1.4.

6188. W. A. & C's, Special Mixture for Wheat, Washington, Alexander & Cooke, Agent, Charlestown, W. Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 2; insoluble, 1; total, 10: available, 9; nitrogen, 0.82; potash 2; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates: nitrogen, ⅕ to ¼ from high grade fish, ⅓ to ½ from high grade tankage, ⅙ to ⅕ blood, ⅙ to 1-5 high grade sulphate of ammonia; potash, ½ to ⅔ from high grade muriate of potash, ⅓ to ½ genuine German kainit. Found: Phosphoric acid, 10.85; reverted, 3.24; insoluble, 1.85; total, 15.94: available, 13.09; nitrogen, 1.10; potash, 5.87; availability of nitrogen, 83; Chlorine, .9.

6189. Washington, Alexander & Cooke's Special Mixture for Wheat, Washington, Alexander & Cooke, Agent, Charlestown, W. Va. Guarantee: (As above.) Found: Phosphoric acid, soluble, 7.73; reverted, 1.30; insoluble, 1.91; total, 10.94; available, 9.03; nitrogen, 0.94; potash, 2.27; availability of nitrogen, 80; chlorine, 1.3.

6191. Washington, Alexander & Cooke, Special Mixture for Wheat, Washington, Alexander & Cooke, Agent, Charlestown, W. Va. Guarantee: (As above.) Found: Phosphoric acid, soluble, 6.65; reverted, 1.70; insoluble, 2.19; total, 10.54; available, 8.35; nitrogen, 0.98; potash, 1.58; availability of nitrogen, 80; chlorine, .2.

Remark: Potash low.

6190. Royal Fish Bone and Poatsh, Washington, Alexander & Cooke, Agent, Charlestown, W. Va. Guarantee: Phosphoric, acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 1.65; potash, 3; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; nitrogen, ½ to ¾ from high grade fish, ½ to ⅓ high grade tankage, ⅕ to ⅓ animal bone, ½ to ⅔ high grade muriate of potash, ⅓ to ½ genuine German kainit. Found: Phosphoric acid, soluble, 6.83; reverted, 1.52; insoluble, 1.28; available, 8.35; nitrogen, 1.65; potash, 3.19; availability of nitrogen, 91; chlorine, .9.

6196. Soluble Alkaline Bone, Washington, Alexander & Cooke, Agent, Charlestown, W. Va. Guarantee: Phosphoric acid, soluble, 10; reverted, 2; insoluble, 1; total, 13; available, 12; potash, 3; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; potash, ½ to ¾ from high grade muriate of potash, ¼ to ½ genuine German kainit. Found: Phosphoric acid, soluble, 9.52; reverted, 2.36: insoluble, 1.25; total, 13.13; available, 11.88; potash, 3.50; chlorine, 1.5.

6197. Raisin's Half and Half Mixture, Geo. Carskadon, Agent, Keyser, W. Va. Guarantee: Phosphoric acid, soluble, 4; reverted, 2; insoluble, 1; total, 7; available, 6; potash, 3; phosphoric acid from high grade Charleston, Florida and Tennessee phosphates; potash, ½ to ¾ from high grade muriate of potash, ¼ to ½ genuine German kainit. Found: Phosphoric acid, soluble 3.89; reverted, 2.80; insoluble, 1.28; total, 7.97; available, 6.69; potash, 3.26; chlorine, 1.6.

6199. Genuine German Kainit, Washington, Alexander & Cooke, Agent, Charlestown, W. Va. Guarantee: Potash, 12; potash from kainit. Found: Potsh, 13.60; chlorine, 2.6.

SWIFT & COMPANY,

Chicago, Illinois.

6104. Swift's Pure Bone Meal, Geo. Carskadon, Agent, Keyser, W. Va. Guarantee: Phosphoric acid, total, 25; nitrogen, 2.50; phosphoric acid from bone; nitrogen from bone. Found: Phosphoric acid, total, 26.51; nitrogen, 2.37; availability of nitrogen, 90.

Remark: Nitrogen low.

6242. Swift's Pure Bone Meal, Geo. Carskadon, Agent, Keyser, W. Va. Guarantee: (As above.) Found: Phosphoric acid, total, 26.38; nitrogen, 2.72; availability of nitrogen, 90.

SWIFT'S FERTILIZER WORKS.

Atlanta, Ga., Wilmington, N. C.

6195. Swift's Superphosphate Standard Grade Guano, Washington, Alexander & Cooke, Agent, Charlestown, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 3; insoluble, 1.50; total, 9.50; available, 8; nitrogen, 1.65; potash, ble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.8235; potash, 1; phosphoric acid from high grade acid phosphate; nitrogen from garbage tankage; potash from kainit. Found: Phosphoric acid, soluble, 3.33; reverted, 4.87; insoluble, 1.23; total, 9.43; available, 8.20; nitrogen. 1.08; potash, 1.11; availability of nitrogen, 87; chlorine, 3.3.

Remark: Chlorine excessive.

6204. Soluble Bone and Potash, Ira Hauck, Agent, Falling Waters, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 2; phosphoric acid from high grade phosphate rock; potash from kainit. Found: Phosphoric acid, soluble, 6.58; reverted, 3.60; insoluble, 0.35; total, 10.53; available, 10.18; potash, 2.80; chlorine, 3.1.

Remark: Chlorine excessive.

6205. Farmer's Wheat and Grass Mixture, Ira Hauck, Agent, Falling Waters, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.8235; potash, 2; phosphoric acid from high grade acid phosphate; nitrogen from garbage tankage; potash from kainit. Found: Phosphoric acid, soluble, 5.42; reverted, 3.27; insoluble, 0.42; total, 9.11; available, 8.69; nitrogen, 0.87; potash, 2.28; availability of nitrogen, 81; chlorine, 2.6.

I. P. THOMAS & SON COMPANY.

1000 Drexel Building, Philadelphia, Pa.

6208. Superior Superphosphate, T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 2; insoluble, 1; total, 8; available, 7; nitrogen, 0.80; potash, 1; phosphoric acid from dissolved phosphate rock and dissolved rough bone tankage; nitrogen, ½% from ground fish and bone tankage; 3-10% from dissolved rough tankage; potash from German kainit. Found: Phosphoric acid, soluble, 4.66; reverted, 2.15; insoluble, 0.81; total, 7.62; available, 6.81; nitrogen, 0.80; potash, 1.15; availability of nitrogen, 75; chlorine, 2.7.

6209. Thomas Wheat and Corn Fertilizer, T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 2; insoluble, 1; total, 10; available, 9; nitrogen, 0.80; potash, 3; phosphoric acid from dissolved phosphate rock and dissolved rough bone tankage; nitrogen, ½% from ground fish and bone tankage; 3-10% from dissolved rough tankage; potash from German potash salts, 2% from kainit, 1% from hard salts (16%). Found: Phosphoric acid, soluble, 5.99; reverted, 2.25; insoluble, 0.83; total, 9.07; available, 8.24; nitrogen, 0.90; potash, 2.93; availability of nitrogen, 71; chlorine, 1.7.

Remark: Phosphoric acid low.

VIRGINIA CAROLINA CHEMICAL COMPANY,

Baltimore, Maryland.

6058. Virginia Carolina Chemical Co.'s Special Bone and Potash, E. R. Judy, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; total, 11; available, 10; potash, 5; phosphoric acid from high grade Charleston, Florida and Tennessee Phosphates; potash, ½ to ¾ from high grade muriate of potash, ¼ to ½ genuine German kainit. Found: Phosphoric acid, soluble, 5.46; reverted, 4.68; insoluble, 1.09; total, 11.23; available, 10.14; potash, 4.43; chlorine, 1.2.

Remark: Potash low.

6116. Virginia Carolina Chemical Co., Special Compound for Wheat, E. Shoemaker, Marlinton, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1; total, 9; available, 8; nitrogen, 0.82; potash, 1; phosphoric acid from muriate of potash, ¼ to ½ genuine German kainit. Found: Phosphoric acid, soluble, 4.30; reverted, 4.40; insoluble, 1.56; total, 10.26; available, 8.70; potash, 3.08; chlorine, 1.3.

ROBERT A. WOOLDRIDGE COMPANY,

Baltimore, Maryland.

6075. Liberty Bell Potash Mixture, Geo. A. Rogers, Agent, Rowlesburg, W. Va. Guarantee: Phosphoric acid, soluble, 10; reverted, 2; insoluble, 1; available, 12; potash, 3; phosphoric acid from dissolved phosphate rock; potash, ½ from manure salts, ½ muriate of potash. Found: Phosphoric acid, soluble, 7.62; reverted, 4.28; insoluble, 0.51; total, 12.41; available, 11.90; potash, 3.68; chlorine, 2.6.

Remark: Source of potash equivalent to kainit.

6239. Liberty Bell Potash Mixture, Thos. Ferney, Agent. Roanoke, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 5.73; reverted, 7.40; insoluble, 1.59; total, 14.62; available, 13.03; potash, 3.03; chlorine, 2.2.

Remark: Source of potash equivalent to manure salts.

6076. German Potash Mixture, Geo. E. Rodgers, Agent, Rowlesburg, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted, 2; insoluble, 1; available, 10; potash, 2; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble, 5.48: reverted, 4.63; insoluble, 0.42; total, 10.53: available. 10.11; potash, 2.84; chlorine, 3.9.

Remark: Chlorine excessive.

6077. Triumph Pure Bone Phosphate, Geo. E. Rodgers. Agent, Rowlesburg, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted, 2; insoluble, 1.50; available, 8; nitrogen, 1.23; potash, 4; phosphoric acid, ¾ from dissolved phosphate rock, ¼ from animal bone and tankage; nitrogen, ⅖ from fish, ⅖ from bone tankage, ⅕ from bone; potash, ½ from muriate of potash, ½ from manure salts. Found: Phosphoric acid, soluble, 4.95; reverted, 4.02; insoluble, 1.15; total 10.12; available, 8.97; nitrogen, 1.45; potash, 4.56; availability of nitrogen, 81; chlorine, 1.8.

6078. Special Potato and Tobacco Fertilizer, Geo. E. Rodgers, Agent, Rowlesburg, W. Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 2; insoluble, 1.50; avaialble, 9; nitrogen, 1.64; potash, 5; phosphoric acid, ¾ from dissolved phosphate rock, ¼ bone tankage; nitrogen, ⅖ from fish, ⅗ from bone tankage; potash, ½ from muriate of potash, ½ high grade manure salts. Found: Phosphoric acid, soluble, 5.01; reverted, 3.75 insoluble, 1.33; total, 10.09; available, 8.76; nitrogen, 1.97; potash, 4.79; availability of nitrogen, 82; chlorine, 1.5.

6237. Special Potato and Tobacco Fertilizer, W. J. Summers, Agent, Little Falls, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble, 5.22; reverted, 4.31; insoluble, 1.83; total, 11.36; available, 9.53; nitrogen, 1.70; potash, 5.63; availability of nitrogen, 92; chlorine, 1.5.

6079. Florida Acid Phosphate, Geo. E. Rodgers, Agent, Rowlesburg, W. Va. Guarantee: Phosphoric acid, soluble, 12; reverted, 2; insoluble, 1.50; available, 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 10.45; reverted, 5.11; insoluble, 0.97; total, 16.53; available, 15.56.

6167. Chieftain Bone Stock Phosphate, Thos. Ferney, Agent, Roanoke, W. Va. Guarantee: Phosphoric acid, solu, ble, 6; reverted, 2; insoluble, 1.50; available, 8; nitrogen, 1.64; potash, 2; phosphoric acid, ¾ from dissolved phosphate rock, ¼ from animal bone and tankage; nitrogen, ⅖ from fish, ⅗ from bone tankage; potash, ½ from kainit, ½ manure salts.

Found: Phosphoric acid, soluble, 4.61; reverted, 4.02; insoluble, 1.27; total, 9.90; available, 8.63; nitrogen, 1.75; potash, 2.04; availability of nitrogen, 86; chlorine, 2.5.

6178. Old Sledge Phosphate, W. J. Summers, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble, 10; reverted, 2; insoluble, 1; available, 12; potash, 5; phosphoric acid from dissolved phosphate rock; potash, ⅖ from muriate of potash, ⅗ from manure salts. Found: Phosphoric acid, soluble, 9.16; reverted, 3.27; insoluble, 0.72; total, 13.15; available, 12.43; potash, 5.67! chlorine, 2.

THE WOOLDRIDGE FERTILIZER COMPANY,

Baltimore, Maryland.

6057. Tiger Bone Stock Phosphate, E. R. Judy, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted, 3; insoluble, 1.50; total, 9.50; available, 8; nitrogen, 1.03; potash, 4.50; phosphoric acid, ¾ from acid phosphate, ¼ from dissolved bone and tankage; nitrogen, ¾ from animal bone and bone tankage, ¼ from sulphate of ammonia; potash from muriate of potash. Found: Phosphoric acid, soluble, 4.73; reverted, 4.13; insoluble, 1.18; total, 10.04; available, 8.86; nitrogen, 1.14; potash, 3.73; availability of nitrogen, 85; chlorine, 2.2.

Remark: Source of potash equivalent to manure salts.

6103. German Alkaline Mixture, Sent in for analysis by R. G. Goodwin, Belington, W. Va. Guarantee: Phosphoric acid, soluble, 7; reverted, 3; insoluble, 1; total, 11; available, 10; potash, 2; phosphoric acid from acid phosphate; potash, ½ from manure salts, ½ kainit. Found: Phosphoric acid, soluble, 6.43; reverted, 5.61; insoluble, 0.82; total, 12.86; available, 12.04; potash, 4.03; chlorine, 2.

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 119. JANUARY, 1909.

The Grapecane Gall-Maker and the Grapecane Girdler.

BY FRED E. BROOKS.

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

ticular species or variety of grape. I have found the evidences of their work on about twenty varieties of cultivated grapes and on the three wild sorts that are commonly found in the woods and grown-up fields of the northern and central portions of this state. These wild sorts are the northern fox grape, *Vitis labrusca,* the "hill-grape" or "frost-grape," *Vitis aestivalis,* and the "chicken grape," or "pigeon grape," *Vitis cordifolia.* Both the gall-maker and the girdler are undoubtedly natives of this country and must have confined their attacks originally to wild grapes and kindred plants.

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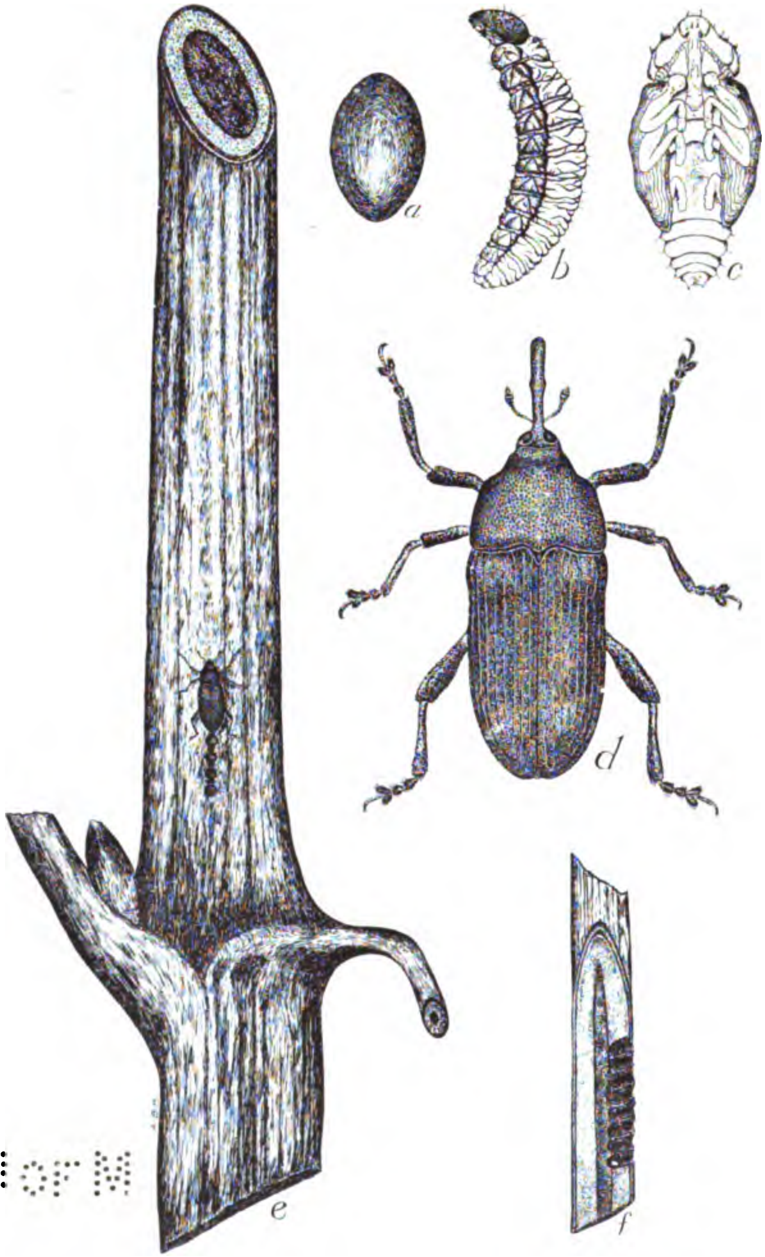

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The Grapecane Gall-maker. a, egg; b, larva; c, pupa; d, adult; e, beetle making the wound in the cane that contains the egg and later causes the gall to form; f, transverse section of wound showing egg in lower chamber. All except "f" greatly enlarged. Drawings by A. B. Brooks.

The Grapecane Gall-Maker.

Ampeloglypter sesostris Lec.

Order Coleoptera; family Curculionidae

HISTORY AND DISTRIBUTION.

About ten years ago this insect was made the subject of an investigation in Ohio, conducted by F. M. Webster, and the results were published as Bulletin 116 of the Ohio Experiment Station. The bulletin gives the more essential facts in regard to the gall-maker and its habits, but since the publication of that paper a few additional points relative to the species have been observed in West Virginia. These observations, together with those already published, give us a fairly complete knowledge of the insect as it occurs in this section of the United States. Webster collected galls from grapecanes in June and kept them until the larvae which inhabited them transformed to beetles in August and September, thus showing that the adult stage is reached in late summer instead of in the spring, as had been supposed previously. I was unable to duplicate this breeding work satisfactorily on account of the extent to which my specimens were parasitized. On the other hand, I watched the female on several occasions while she was engaged in egg-laying, an operation which I believe has not been described heretofore. Most of my observations on this species were made at French creek, W. Va., in the summer of 1905. where, at that time, the beetles were very abundant. Since 1905 but few specimens have been seen in that locality and examples of their work have been correspondingly scarce.

The species was described by LeConte in 1876, from specimens collected in Missouri. Since that time it has been reported from Minnesota, Ohio, Pennsylvania and other eastern, southeastern and mid-western states.

THE ADULT INSECT.

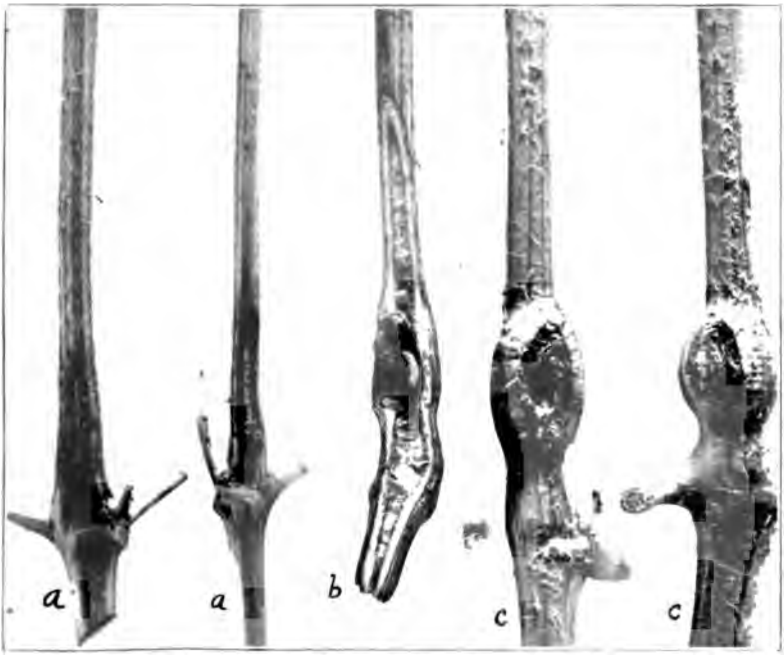
The gall-maker in its adult stage is a reddish-brown beetle which measures about one-eighth of an inch in length and one-twentieth of an inch in width. It has a curved snout, one-third as long as the body, which it carries projecting forward and downward. The thorax and head are finely and densely punctured and the wing-covers are furrowed longitudinally. The beetles appear on grapevines during the month of May and are present for several weeks. They are so small, however, that they rarely attract attention. Soon after their appearance the females begin to oviposit in the young canes, and after the eggs are laid the parent beetles of both sexes disappear in late June or July.

The beetles feed sparingly on the vine and in doing so make little pits in the young tendrils, in the buds and bark on new canes and in the mid-ribs on the underside of leaves. It is probable also that the female swallows some of the tissue which she tears from the cane in making her egg-chamber. The injury which results from the pits eaten in the plant is insignificant, but the manner of feeding is otherwise of some interest, since it indicates that the beetles may be killed with arsenical sprays.

The beetles are active only during warm days. In cool or rainy weather and at night they hide beneath the strips of bark adhering to old canes, or remain motionless on the underside of the leaves.

APPEARANCE OF INJURED VINES.

The injury done to the vines by this insect is in the shape of gall-like growths that begin to develop on the new canes early in the summer. These galls are abrupt swellings of the



Photographs showing injury done by the Grapecane Gall-maker. a, a, newly made wounds; b, larva feeding in the cane and the gall beginning to form; c, c, fully developed galls. Natural size.

cane to something like twice its normal diameter, the enlargements being an inch or an inch and a half in length. The swelling is about uniform around the cane except that on one side there is a deep longitudinal scar from a half to three-fourths of an inch in length. This scar comes from a wound made by the female beetle in preparing a place to lay her egg. The gall is almost invariably located just above a joint of the cane. I examined several hundred of the galls and found only one in which the lower end was as much as an inch above a joint. The one exception was that of a gall located three-fourths of an inch below a joint. The cane on which this gall was found was being trained in a horizontal position and the gall occurred just below instead of just above the joint, evidently through an error on the part of the beetle that made the wound which caused the gall to form. Occasionally a single cane will bear four or five galls, and on one cane I found nine. Strange to say, the female nearly always selects the joints of the young cane beyond the last or outer bunch of fruit for her points of attack. Consequently, if an infested cane is bearing a bunch of fruit at each of the three joints nearest its base the galls will not appear at these joints, but the first one will be found not nearer to the base of the cane than just above the fourth joint. In several cases where canes were bearing but two bunches of fruit, galls were found at the third joint. This peculiarity was noticed so often that there seems little doubt that the female rejects the fruiting joints as being unsuitable places for her eggs to be deposited. Just why she should discriminate against the fruiting joints is not very clear.

The swelling of the cane at the point of injury begins soon after the wound is made, but the gall does not reach full size until six or eight weeks later. On vines of varieties that produce dark-colored fruit the bark and wood about the wound soon takes on a reddish-purple color. This discoloration does not occur on varieties that bear white or green fruit.

The presence of the galls appear to have but little effect on the growth and vigor of the cane. Occasionally a cane that has no support will be broken by the wind or by its weight of leaves at the point of injury. In tying up the canes after pruning in the spring they will sometimes break more readily at the galls than elsewhere. In pruning vines affected with the galls this should be borne in mind and the canes on which no galls are found should, when possible, be preserved for fruiting.

THE EGG AND HOW IT IS DEPOSITED.

The egg is oblong-oval in shape, .016 inch wide and .025 inch long. In color it is yellowish-white and the surface is smooth. It was found to hatch in from seven to ten days, but the exact period was not noted.

The scar which has been mentioned as occurring on the side of the gall is the result of a slit, or rather of a row of closely connected holes which the female makes for the reception of a single egg. The making of this wound and the subsequent feeding of the larva which hatches from the egg placed within it constitute practically all the injury which the species does the vine.

The female often spends several hours in the elaborate operation that attends the laying of a single egg. The work is carried out with so much show of design in every movement that it may be worth describing in detail. The case taken is that of a female that was observed on May twenty-third, 1905. After crawling about over a young cane for some time she took a positon about half an inch above a joint, with her head directed toward the tip of the cane. With her snout she then bored a small, ragged hole to the heart of the cane. At the entrance the hole was about one-twentieth of an inch in diameter, but at the inner end it was somewhat larger. When the hole was completed the beetle turned about and applied the tip of her abdomen to the opening and deposited an egg, attaching it to the wall of the hole at the inner extremity. She then resumed her former position and moved up the cane a distance about equal to the diameter of the hole. The snout was then extended forward as far as possible and the end pressed against the bark and then drawn downward to the margin of the hole, which was directly under the head of the insect. By approaching slowly and moving with care I was able without disturbing her to watch every movement of the beetle through a hand lens. By this means I could distinctly see after each scraping movement some hair-like fragments of the bark held between the jaws at the end of the snout. These fibers of bark were thrust into the hole and the scraping continued without rest until the hole was packed full and quite a groove had been made in the bark by the removal of the fragments.

When the hole had been filled to her satisfaction she began a second hole at the upper end of the groove made in gathering material to plug the first. This hole was completed with the same care as the other, and when it was done the beetle turned and applied the tip of her abdomen to the entrance just as though she were about to lay another egg. Instead of an egg, however, she deposited only a minute drop of clear liquid and then proceeded to fill the hole in the same manner in which she had filled the one containing the egg. The work of making the holes, excreting the liquid into each and then filling them with fiber was continued until the row contained eight holes. After the completion of the eighth hole the insect crawled away. The time spent in making and filling the last hole was a little less than that expended on the first.

I afterward found that eight holes was hardly an average number for a wound. One wound was found that consisted of fourteen holes, and several others were noticed that contained twelve or thirteen. The time occupied by four individuals which were watched during their egg-laying operations averaged for each thirty-one minutes in preparing the first chamber, three minutes in laying the egg, twenty-four minutes in filling egg-chamber and making next hole, one minute in excreting liquid, twenty-one minutes in filling hole and making next, with about the same ratio of decrease in the time spent on each hole until the series was finished.

Most of the eggs are produced between May fifteenth and June fifteenth, though I have seen a few wounds that were made after the latter date. A beetle will lay two eggs in a day, in rare instances three, and possibly four may be produced. It is doubtful if one individual ever lays more than twenty-five to forty eggs.

OTHER STAGES OF THE INSECT.

The larva is a footless grub about two-fifths of an inch in length. Its color is yellowish-white with a light brown head and dark brown jaws. It feeds, first, in the mutilated wood about the egg-chamber, and later works its way along the heart of the cane, either above or below the gall. It reaches full growth in from eight to ten weeks and then changes to a pupa within its burrow. The pupae which I found were situated at the point where the burrow penetrated the joint just below the gall.

Webster found all stages of the insect in the galls on August eleventh, with some of the adults making their way out. I found both larvae and pupae on August tenth, but could find no adults. The pupa stage is evidently of short duration, as Webster found that in September nearly all the insects had transformed to beetles and had left the galls. The beetles, according to Webster, hide away for the winter in fallen leaves or matted grass, and emerge from hibernation the next spring to oviposit in the new canes.

NATURAL ENEMIES.

Webster called attention to the fact that the wound made by the female in the cane does not heal, but remains open so that the young insect on attaining the beetle stage has a ready exit by which it may quit the gall. While the opening allows the gall-maker to escape from its burrow in the cane it is otherwise of great disadvantage to the larva, since it admits parasites of several kinds which prey upon it. Webster found two species of parasites attacking the gall-maker; a Tachina fly, *Myiophasia aenea* Wied. and an hymenopterous parasite, *Neocatolaccus, tylodermae* Ashm. As has been stated, the specimens which I observed were very badly parasitized. On July tenth I examined forty-five galls. Eight of these contained larvae of the gall-maker, thirteen were empty and twenty-four contained the larvae or pupae of parasites which had killed the gall-maker. Another examination of fifty galls on August tenth showed even a greater mortality of the gall-maker as a result of parasite attacks. The parasites which I reared were all hymenopterous species. I have not been able to obtain the specific names of these species, the most abundant, however, was a Chalcis fly, *Eurytoma* sp., as determined by Mr. J. C. Crawford, of the National Museum.

PREVENTIVE MEASURES.

The gall-maker may be destroyed by cutting out and burning the canes on which the galls occur during the months of July and August. The habit which the female has of depositing her eggs at the joints above the terminal bunches of fruit makes it possible to practice this method without destroying any of the crop. Webster recommends collecting and burning the fallen leaves and other rubbish in the vicinity of vineyards during the fall and winter in order to destroy the hibernating beetles.

Since the beetles take most of their food from the exposed portions of the vine, there is little doubt that they may be killed by spraying with Paris green or arsenate of lead. The spraying for the gall-maker will also be effective against the grape curculio, the grape berry-moth and several species of insects that attack grape foliage. The poison may very conveniently be combined with Bordeaux mixture, thus making the spray a preventive of the several fungous diseases of the grape, as well as a destroyer of the insect enemies.

The Grapecane Girdler.

Ampeloglypter ater LeConte.

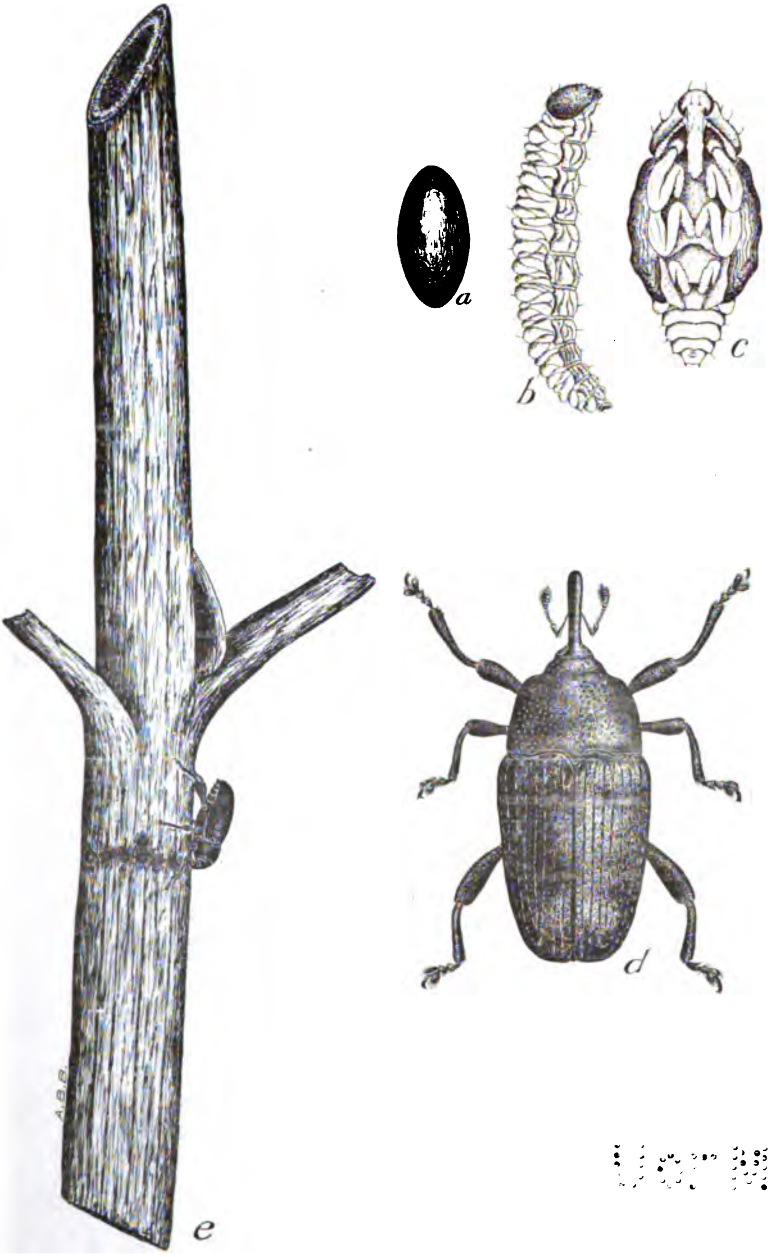
Order Coleoptera; family Curculionidae.

HISTORY AND DISTRIBUTION.

This insect is not often mentioned in entomological literature, probably for the reason that in the past it seems to have confined its attacks chiefly to the plant known as Virginia Creeper or Five-leaved Ivy, *Ampelopsis quinquefolia,* and has seemed, therefore, of but little economic importance. In this state it appears now to have developed a preference for the grape. In several localities I have seen grapvines presenting a ragged appearance on account of the dead tips resulting from the insect's attacks, but I have never been able to find either the beetle or evidences of its work on Ampelopsis.

The species cannot now be regarded as a pest of very serious consequence, except in rare instances, but, as it has several times attracted attention as an enemy of the grape in this state during recent years, and as heretofore but little has been known in regard to its habits, it seems worth while to publish the following notes.

The distribution of the species seems to be quite general throughout the eastern and mid-western sections of the U. S. In 1862 Mr. C. V. Riley, in his First Report on the Noxious Insects of Missouri, mentioned it as forming galls on the common creeper. At about the same time Mr. Benj. D. Walsh had specimens of the insect in his collection in Illinois, marked *"Madarus ampelopsis."* It was not until the year 1876 that a description of the beetle was published. In that year Dr. John



The Grapecane Girdler. a, egg; b, larva; c, pupa; d, adult; e, beetle girdling the cane just below its egg-chamber. The upper one of the twin holes in the center of the cane contains the egg. All greatly enlarged. Drawings by A. B. Brooks.

L. LeConte described it in his work on the Rhynchophora of America, and gave to it the name which it still bears. Le Conte gives its geographical distribution as "Southern and Western States." Since the description was published the species has received but infrequent and brief notice, but has been recorded as occurring in several states from Missouri to Pennsylvania.

It seems a little strange that in nearly every case where it has been mentioned it has been referred to as a gall-maker on Ampelopsis. As already stated, I have not found it on Ampelopsis in West Virginia, although this plant grows profusely in the localities where the insect has ben observed in greatest abundance. Ampelopsis is nearly related to the grape, however, and if this insect has now given up a once favorite food for another which it finds more to its liking the case is by no means unique in the history of insect behavior. In 1895 Dr. F. H. Chittenden remarked (Insect Life, Vol. VII, p. 387:) "Species which are known to affect Ampelopsis and other genera of the vine family will be found in time on the grape. Of such is *Ampeloglypter ater*." It now seems that this prediction has come true, even to the extent of the old food plant being abandoned, temporarily at least. The appellation "gall-maker" does not apply to the species as I have found it affecting the grape. The term "girdler," however, is entirely applicable. When the female lays her egg she carries out an elaborate program, one act of which is to girdle the cane below the point where the egg is inserted. The proceeding is an interesting one and is described in detail further along in this publication.

APPEARANCE AND HABITS OF THE BEETLE.

As has already been stated, the beetles of this species resemble those of the gall-maker, except that in color they are black. The length is the same (one-eighth of an inch) and the general shape is similar. The taper at the hind end of the wing covers is a little more abrupt and the prothorax is less densely punctured and more suddenly rounded in front. The beak is about the same length, but is stouter and more curved. This species, like the other, appears on the grapevines in the spring just before the blossoming season. Egg-laying continues for about a month. The first eggs discovered were deposited on May thirteenth and the last on June tenth. No beetles were seen before May thirteenth, though they were probably abroad a few days in advance of that date. Several specimens were seen after June tenth moving about or feeding on the vines, but the last of this generation soon disappeared. But one generation is produced annually.

The wound which the beetle makes in ovipositing causes the tip and terminal leaves on the young cane to drop over and die, and shortly afterward to fall from the vine. The egg is not carried to the ground with the prunings when they fall, but it remains in the vine, and the larva which develops therefrom feeds in the heart of the stump from which the leaves and tip were removed.

THE EGG.

The egg is dingy-white in color, oblong, eliptical in shape, .030 inch long and .014 inch wide. An egg laid on May nineteenth hatched on May twenty-ninth. Other examples observed showed the period of incubation to be nine or ten days.

HOW THE EGG IS LAID.

During my observations of this insect I several times came upon the female just as she was putting the finishing touches on one of her egg-laying operations, but it was some time before I learned the sequence in which the different parts of the work were performed. Finally, on May twenty-first, 1908, I had the opportunity of watching the procedure throughout. The female observed was first seen at 12:40 p. m., just as she settled down and began working near the tip of a young Moore's Diamond grapecane. Her position was about half an inch below a leaf-joint, and as she worked her head was directed downward, or toward the base of the cane. She first drilled with her snout a hole that extended through the bark and for a short distance into the soft wood beneath. After spending thirty-one minutes in making the hole she turned about and pressed the posterior extremity of her abdomen into the opening and deposited an egg. She then resumed her former position and began filling the hole over the egg with threads of bark torn from the cane immediately below the opening. In ten minutes the hole was filled and the beetle moved an eighth of an inch below and made a second hole which was similar to the first except that the latter extended only through the bark. When the hole was finished she applied the tip of the abdomen to the entrance, just as before, but laid no egg, nor could I determine that any deposit of liquid or other matter was left, as in the case of the gall-maker when it performs a similar act.

This second hole was not filled, but after the anal extremity was withdrawn the beetle turned about, moved a tenth of an inch to the left and made another hole. Again the tip of the abdomen was inserted and then withdrawn, after which another hole was made to the left at about the same distance as before. After making the third hole the beetle moved to the opposite end of the line and added two more and then returned to the left end and continued to drill until ten holes were in the row. The tenth hole completed the ring, which now extended in a regular line around the cane. The tip of the abdomen was inserted in all, but no eggs were laid in the holes composing the girdle. During the excavation of all the holes the beetle worked with her head directed downward, or away from the tip of the cane.

When the girdle was completed the beetle spent several minutes in going from one to another of the holes and inserting her beak into each as though to make sure that everything had been done properly. She then rested for two minutes, after which she crawled to the first joint above and ascended the stem of a leaf that grew from that point. Half way up the stem she began another puncture, this time working with her head upward. The stem leaned considerably from the perpendicular, and this first puncture was made on the underside of the stem, but slightly to one side of the line of inclination. This puncture was followed by others, made close together and in a transverse line, until the row extended entirely around the stem except that the ends of the row did not meet by about the twentieth of an inch on the under side. These punctures were made so near together that their margins met and the stem was severed above so that it broke over and hung only by the thread of bark beneath that separated the holes on the opposite ends of the girdle. The beetle then crawled down the stump of the leaf-stem and up the cane to a point just below the second joint above the place where she had girdled the cane. Here she made another incision, in every way similar to that made on the leaf-stem. When completed the tip of the cane broke over at that point and hung by the thread of bark that had been left on the underside. The beetle then crawled about inspecting, first the cut made in the leaf-stem, then the girdle near the place where the egg was deposited, and then went back to have a look at the last cut which she had made in the cane. Seeming satisfied with her work she then left the place by crawling down the cane. At a joint some distance below she stopped and began feeding from a bud, when I placed her in a collecting bottle.

The operation lasted for three hours and forty minutes, and there were only two minutes of the time during which the beetle was not actively at work. I have seen girdled tips where two or three leaf-stems, and in some cases tendrils and bunches of fruit, had been cut. In such cases the time required for completing the operation must have been longer than in the one described.

A few points observed in this and subsequent egg-laying operations of the same species may be of interest to those who like to study the motives and meaning of the more or less intelligent acts of insects. The plugging of the hole in which the egg is placed is evidently done to exclude enemies. In two cases I removed the plugs soon after oviposition took place and the next day the eggs were found and devoured by minute mites which occurred rather abundantly on the canes. The invariable practice of the female of working during the excavation and filling of her egg-chamber and of drilling the holes for the girdle below with her head directed downward, and then of reversing this position when she comes to pruning off the tips may also be accounted for. In working with her head pointing toward the ground the weight of the body is above and she can easily bring more pressure to bear with her snout, which facilitates the work of drilling. In doing the pruning, we may suppose that she reverses ends that she may retain a stationary foothold and avoid the possibility of falling with the pruned-off end.

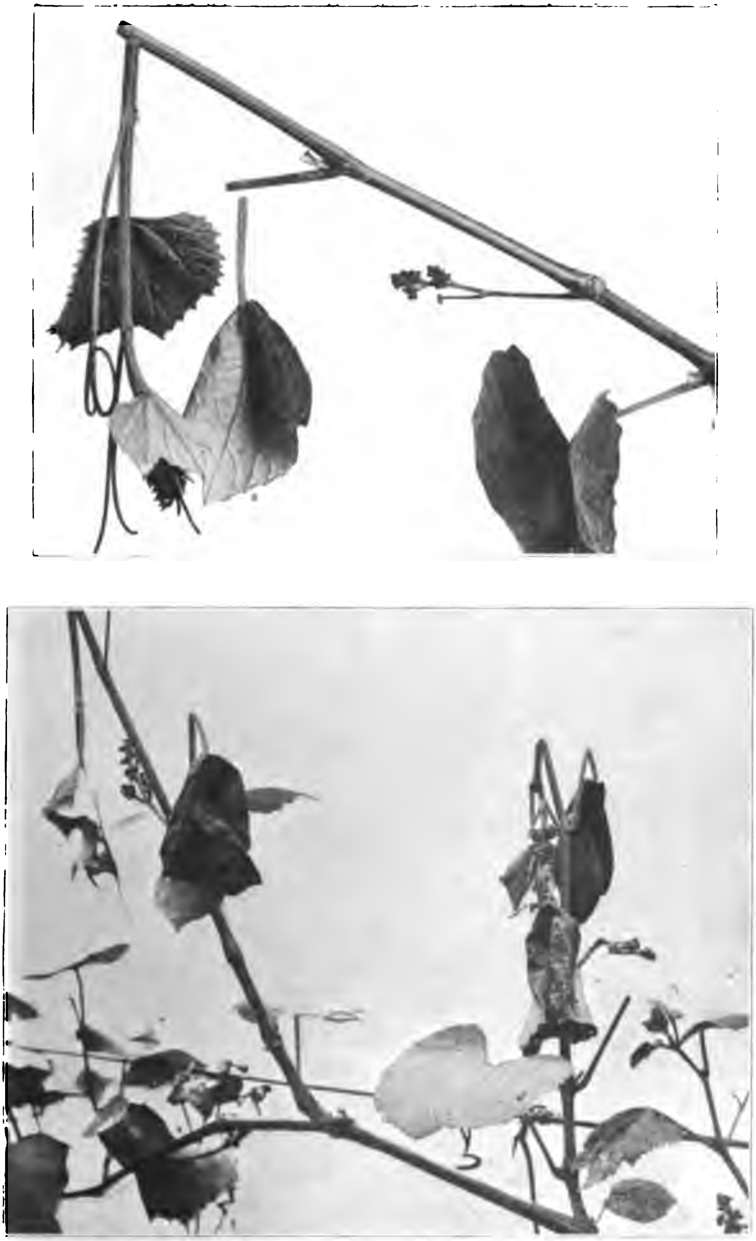
In one case I saw a beetle cut off a tip that was held in place by one of its tendrils being coiled around a near-by cane. When the severed tip failed to drop she crawled back and forth over the cane for some time, both above and below the cut which she had made. She went twice to the extreme end of the cane and examined thoroughly a young leaf that grew there, but returned each time to the cut, and once did a little additional excavating with her snout, but did not sever the thread of bark on the underside. At last she crawled out the tendril to where it was wrapped about the other cane, and then turned and retraced her way to near the base of the tendril, where in two places she ate it about half off, but not sufficiently to permit it to part. After this was done she quit the place and moved away down the cane. The unusual action of the insect after the severed tip failed to fall almost persuaded me that she actually discovered that the tendril was obstructing the working out of her plan and that she attempted to remove the obstruction by cutting it off. However, on other occasions I saw beetles feeding on the tendrils and it is possible that in this case the insect considered her work done and in her seeming agitation was only looking for a suitable place to satisfy her hunger.

I saw another female make two of her characteristic incisions in pruning a cane but she did not continue the cutting in either quite to the point where the severed ends fell over. A passing breeze a few minutes later broke both, but, before they fell, the insect had completed her task and left. This observation also indicated that the failure of a severed part to drop might not be expected to bother the insect very seriously.

Another interesting case was observed in which two tips crossed each other. Just below the point of intersection an egg had been laid in one of the canes and a girdle made in the usual manner. The beetle had then moved on to complete the operation, but, at the point where the two canes met, she had accidentally taken the wrong cane. From this she had cut a leaf and the tip. In another case the female in making her girdle below the egg-chamber carried the line of holes around the cane obliquely, so that the ends did not meet by about a fourth of an inch. She continued adding holes to the line until it reached nearly around the cane the second time and then gave it up.

It is interesting to compare the methods of this insect with those of other species that girdle twigs or small branches in order to kill or partly kill the wood in which their eggs are laid and their larvae are to feed.

The "hickory twig-girdler," *Oncideres cingulata*, a "long-horned" beetle, lays its eggs in the branches of hickory and other trees and then girdles the branch below, by cutting a deep groove with its strong jaws so that the branch above dies and is frequently broken off by the wind. The "elm twig-girdler," *Oberea ulmicola,* a beetle of the same family, attacks elm in a similar manner. The female cuts a deep groove around a twig so that it is easily broken off by the wind. Below the groove she cuts a slit in the bark and deposits an egg and then moves further down the twig and girdles it a second time, now merely cutting through the bark so as to deaden the part above. Another species of the same genus, known as the "blackberry cane-girdler," *Oberea bimaculata,* cuts a double girdle and lays an egg between the two, in a similar manner, in the young canes of blackberry and raspberry. Still another "long-horned" beetle, the "oak-pruner," *Elaphidion villosum*, lays its eggs in the



Photographs showing tips of canes pruned by the Grapecane Girdler. The photograph above was made within ten minutes after the injury was done. In this picture the girdle is faintly distinguishable just below the joint where the leaf stem has been severed.

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branches of oak and other trees but leaves the girdling to be done by its larvae. In this case the larva feeds in the heart of the twig until it is nearly full grown and then cuts the twig almost off at the lower end of its burrow. Immediately after the cut is made it retreats into the burrow above and waits for the wind to blow the twig to the ground, where it completes its transformation within the burrow.

The adult of the "raspberry cane-maggot," a two-winged fly of the genus *Phorbia,* lays its eggs near the tips of young raspberry shoots. The larva which hatches enters the cane and after working its way downward for several inches it encircles the shoot several times, with a spiral groove made just beneath the bark, which kills the shoot above, and the larva feeds thereafter on the dead wood. The "current stem-girdler," *Janus integer,* a saw-fly, punctures the bark of current bushes near the ends of growing tips with its saw-like ovipositor and lays an egg in the orifice. Just above the egg, it girdles the twig by making several deep cuts with its ovipositor so that the twig breaks over. The larva which develops from the egg feeds on the pith of the stump.

There are other species that operate in a similar manner, but the ones that have been mentioned will serve to show that the peculiar habit, in one form or another, is shared by insects belonging to widely separated groups. It is interesting that so many species, which in most respects do not resemble each other in the least and which represent at least three orders, have adopted some form of this peculiar way of providing for the safety and comfort of their progeny.

THE LARVA AND HOW IT AFFECTS THE CANE

The larva is a footless grub about one-fourth of an inch in length. Like the larva of the gall-maker, it is white with a light-brown head. It feeds in the heart of the cane, eating out a burrow that extends only between the two joints on either side of the place where the egg is laid. The larval stage covers a period of something over a month. In one case I got an exact record of its duration which was thirty-four days.

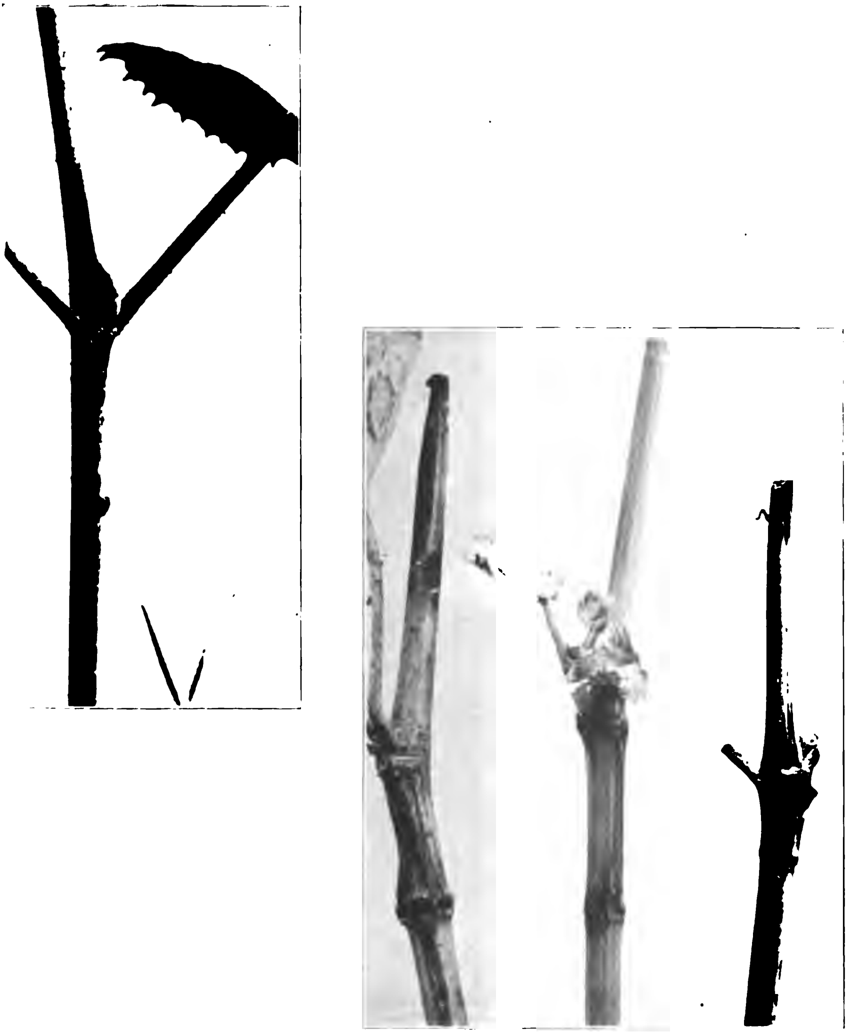
The cane in which the larva feeds dies back to the first joint below the egg-chamber and drops from the vine in about six or eight weeks after the eggs are deposited. The larva changes to a pupa soon after the dead section of the cane drops.

PUPATION.

When the larva is ready to pupate it packs its burrow in two places with pellets of fiber scraped from the surrounding cane. These pellets are placed about a fourth of an inch apart at a point about mid-way between the ends of the section of cane. Within the space between the pellets the larva changes to a pupa. In about two weeks the pupa changes to the adult insect.

FULL LIFE CYCLE.

One individual was kept under close observation from egg to adult and all the changes of transformation noted. The egg was laid on May nineteenth, egg hatched May twenty-ninth, larva pupated July second, adult appeared July fourteenth. This individual was more precocious, however, than several others that were watched less closely and it can hardly be considered as a fair example with which to illustrate the life cycle of the species. The period occupied by its transformation was only fifty-six days, whereas, from sixty-five to seventy days was the average period for the transformation of the others noted. Most of the pupae change to adults early in August. The beetles remain for some time in the chambers where they have developed and then work their way out and escape. That they pass the winter in the beetle stage there is no doubt, but their place of hibernation was not found. Most likely they hide away, like the gall-maker, among fallen leaves or in rubbish



Photographs showing adult Grapecane Girdler resting on vine and injury done to tips of canes. Natural size.

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heaps, old stumps, about fences or in sheltered places in the woods.

NATURAL ENEMIES.

Reference has been made to a mite that entered the egg-chambers of the beetle when they were opened and destroyed the eggs. Specimens of this mite were collected and forwarded to Washington where they were determined as *Tyroglyphus cocciphilus* Banks, a species that has been known to feed on scale insects. I believe that this, or a similar mite, sometimes finds its way into the undisturbed egg-chambers of both the grapecane girdler and the grapecane gall-maker and destroys the eggs. I have found in fresh wounds in the canes the empty egg-shells of the beetles which had every appearance of having been attacked by the mites.

Two species of hymenopterous parasites were found attacking the larvae of the girdler as it burrowed in the cane. Both species after killing the girdler construct little cocoons within the burrow in which they transform to adult insects. One of these was identified by Crawford as *Macrodyctium sp.* The other species was not determined.

MEANS OF CONTROL.

The same measures recommended for use against the gall-maker may be adopted in dealing with this species. The injured canes are quite conspicuous early in the season and by cutting them off a few inches below the wounds and burning them the eggs and larvae may be destroyed. The insects may also be destroyed by raking together and burning all litter beneath grapevines in July, while the larvae and pupae are in the fallen canes on the ground. Spraying the vines in May and June with arsenical poisons, as is required for holding other pests of the vine in check, will most certainly destroy the beetles of this species.

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 120. APRIL, 1909.

Cabbage Worms

AND

Suggestions for Destroying Them

By W. E. RUMSEY AND FRED E. BROOKS.

(The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.)

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April 16, 1909.

This bulletin concerning Means for Controlling Enemies of the Apple is the second of a series of practical bulletins to be issued by this Station from time to time for the promotion of the horticultural and trucking industries of the State. The first bulletin is upon the subject of Certain Enemies of Cabbage and How to Destroy Them.

J. H. STEWART.
Director.

Apple Enemies, and How to Fight Them

W. M. Munson.

As the apple becomes an increasingly important factor in the wealth of the state, the question of protecting this fruit from the ravages of disease and of insects and other enemies, becomes of correspondingly greater moment. The most commonly accepted method of treatment, at present, is by the use of the modern spray pump.

THE REASON FOR SPRAYING.

By far the larger proportion of the enemies of the apple may be held in check by spraying the trees with one or more of the common insecticides or fungicides now offered. By a combination of materials, several enemies may, in many cases, be successfully checked with one application. There should, however, be a definite purpose in view for every application. The mere fact of spraying, is not enough. Vast sums of money are wasted every year because of the use of wrong materials, improper mixing, slovenly or inefficient field work with the pump, or neglect of the operation until too late in the season. *Delays are dangerous! Spraying is a preventive measure and not a cure*, and should be looked upon as, in a sense, plant insurance.

HOW TO SPRAY.

Use a good spray pump, and do not fear to apply plenty of pressure. The best results are obtained from the use of a power sprayer which will give 100 to 200 pounds pressure. *Sprinkling is not spraying!* The spray should be applied as a fine mist which will settle all over the tree,—on the under as well as on the upper surfaces of the leaves. There is a tendency in some parts of the country to return to the use of the coarse nozzle which was in use 20 years ago, and to depend upon high pressure to force the spraying material where desired. It is doubtful, however, if, in our moist climate, and for general orchard practice, this can be recommended, as yet. Studies of this question are in progress at several experiment stations at the present time.

The fine mist referred to, is best produced by using a fine nozzle (as Vermorel, Friend, Mistry, or some similar type) and high pressure; and *every portion of the tree should be covered,*— top, sides, branches, trunk.

In order to reach the tops of the trees, a bamboo extension rod is almost indispensable (but be sure and get one with a shut-off cock at the base.) *One thorough spraying at the right time is worth 10 careless treatments.*

WHEN TO SPRAY.

An early spring treatment with lime-sulphur, or with copper sulphate or Bordeaux mixture, is a most valuable aid in controlling the fungous diseases, such as apple scab, bitter rot, canker, etc.; also it might be added, for leaf curl and scab of peach, and for brown rot, plum pockets, and probably black knot of plum. Spray early and, especially in wet seasons, spray often, —not fewer than 4 or 5 times during the season. If a heavy rain occur soon after spraying, repeat the treatment. Spraying mixture that is washed to the ground is of no value as a protection to the trees. If one of the soluble oils is used, application should be made in fall or early winter.

For the San Jose scale, spraying *must* be done in fall, winter or spring, before the buds start. It is generally conceded that spring is the best time for treatment with lime-sulphur mixture, but owing to pressure of other work, and to the condition of the ground in spring, this treatment is frequently given too early for the best results.

OTHER FACTORS INVOLVED.

Spraying will not insure a bountiful crop of perfect fruit, any more than carrying an insurance policy, or maintaining a well filled medicine chest will ward off the ills to which man is subject. Clean cultivation, the removal of dead wood and of decayed and diseased fruits, leaves, and branches; the admission of air and sunlight, by proper pruning; a well drained, friable soil; an abundance of plant food—these and many other factors which go to make up what is universally recognized as "good culture," are essential to the fullest success and satisfaction in commercial fruit growing.

SOME INSECT ENEMIES.

The insect enemies of the apple may be conveniently arranged in groups, *viz.*: those affecting the roots, the stems and branches, the foliage, and the fruit.

The chief enemy attacking the root, is the wooly aphis. Of insects affecting the stem and branches, the worst are: borers, scale insects, and aphids, including the green lice and one form of the woolly aphis; the foliage enemies include canker worm, tent caterpillar, red-humped caterpillar, bag worm and green aphis; and the fruit enemies include the codling moth larvae, or "apple worm," and the curculio. Specific treatment is required for some of these pests, as with the San Jose scale; while in other cases a general aplication of preventive or destructive measures will answer for several.

The *woolly aphis*, as it appears on the roots, may be destroyed by injecting carbon bisulphide into the soil about the base of the tree; also by removing the top soil for a distance of 2 or 3 feet from the base of the tree, and applying a liberal quantity of tobacco dust. Tobacco dust is the safest and most commonly used remedy. For the wooly aphis on the limbs, spray with kerosene emulsion (formula 7).

Borers, both flat-headed and round-headed, are best destroyed by means of a knife and a sharp wire; search being made for them on each individual tree every fall and spring. Preventive measures are sometimes used in the shape of protective bands at the base of the tree; also by the use of some sticky substance, like printers' ink, or tanglefoot, which hinders the beetle from laying its eggs.

The *scale insects* which give most trouble are the San Jose scale, the oyster-shell bark louse, and the scurfy bark louse. The standard remedy for all of these enemies is to spray, in winter or early spring, before the buds expand, with the lime-sulphur mixture (formula 1) or with one of the soluble oils (formula 2). This spraying must be done when the trees are dormant—from November to March or April—as suggested on page——.

Aphids, or *plant lice,* which are often so numerous the latter part of the summer, may usually be detected by the presence of ants in the tops of the trees and on the new twigs. These lice injure the tree by sucking the plant food which should go to mature the new growth. The ants themselves do no harm. They simply feed upon the honey dew, a sweet, sticky substance excreted by the lice. To destroy the lice, spray with kerosene emulsion (formula 7) when the insects are discovered. If spraying is delayed until the leaves curl, many of the pests will escape.

For *leaf-eating insects, like* tent caterpillar, canker worm or bag-worm, spray with arsenical poisons (formula 5 or 6) when the insects first appear. Promptness is very important, as the insects are much more easily killed when very young.

For *codling moth* and *curculio,* which attack the fruit, spray with formula 5 or 6, just after the blossoms fall and once or twice later, at intervals of 10 days or 2 weeks. Use formula 6 instead of plain Bordeaux mixture, for general spraying during the summer.

COMMON FUNGOUS ENEMIES.

The most commonly recognized diseases of the apple, in West Virginia, are: apple scab, bitter rot, leaf-spot ("frog-eye"), cedar rust, and canker. With all of these troubles, preventive measures are of the greatest importance. Destroy all diseased leaves, fruit and wood, and spray with the proper material before the plants are attacked. Spraying may check the spread of some diseases, but it will not serve as a cure.

For *apple scab*, spray with copper sulphate (formula 4) before the buds open; with Bordeaux mixture and arsenate of lead (formula 6) immediately after the blossoms fall, and again 2 weeks later. If the season is very moist, repeat the application once or twice during the summer; but usually 3 or 4 sprayings are sufficient.

For *bitter rot*, remove all diseased fruits which remain on the tree, and burn these, together with all infested fruit and litter under the tree; spray with copper sulphate (formula 4) before buds open,—unless lime-sulphur mixture has been used for the scale; after July 1, spray about once in 2 weeks with Bordeaux mixture (formula 3). If the season is very wet and hot, it may be necessary to spray the particular varieties attacked as often as every week or 10 days, removing and destroying all diseased fruit as it appears; if season is very dry, less frequent spraying is required. Blighted twigs and cankered wood should be removed and burned, and too much emphasis can not be laid upon the importance of burning at once the old mummied fruit, both on the tree and that which has fallen, and the newly diseased fruit as fast as it appears during the summer.

For *leaf spot* ("frog-eye"), destroy all litter and diseased leaves around the trees; spray with copper sulphate (formula 4) or with Bordeaux mixture (formula 3*a*) before blooming, if lime-sulphur has not been used; spray with Bordeaux-arsenate (formula 6) immediately after blooming, and repeat at intervals of three or four weeks during the season. The number of sprayings required will depend upon the character of the season.

For *cedar rust*, burn all diseased leaves and litter; destroy all cedar trees within ½ mile of the orchard; spray with Bordeaux mixture as for other leaf diseases.

For *canker*, remove and burn all cankered twigs, and cut out cankered spots on trunk and large branches, painting the wounds with pure white lead and linseed oil to facilitate healing. Canker of the wood appears as one form of several diseases of the apple. Spraying with Bordeaux mixture for these diseases will tend to reduce this trouble.

SUMMARY OF TREATMENT FOR APPLE ENEMIES.

(a). Burn all deceased leaves, fruit and other litter; also cut out and burn all dead limbs and diseased spots on trunk and branches.

(b). For San Jose scale, spray in fall or early spring with lime-sulphur mixture or one of the soluble oils. The lime-sulphur treatment is also an aid in the control of fungous diseases.

(c). In the absence of the lime-sulphur treatment, spray in early spring, before buds open, with copper sulphate or strong Bordeaux mixture.

(d). Spray immediately after blossoms fall with Bordeaux mixture and arsenate of lead, and repeat in about 2 weeks, with subsequent treatments in July and August, for leaf diseases, apple scab, and codling moth. If leaf eating insects prove troublesome at any time, use formula 6.

GENERAL SUGGESTIONS.

1. Wash spray pump and nozzles every time when through using.

2. Keep all materials labelled and out of reach of children and animals, remembering that most spraying materials are *poison*.

3. Mixtures containing copper sulphate or arsenate of lead should be made in wooden tubs or earthen jars, not in tin or galvanized iron vessels.

4. Arsenical sprays should not be applied to fruits just before harvesting.

5. Trees should not be sprayed when in bloom. Such treatment reduces the crop and kills the bees, which latter are among the best friends of the orchardist.

6. Learn to know insects and diseases by their appearances and by their work. No one treatment is effective for all. If in doubt, send a specimen to the Experiment Station.

FORMULAS FOR SPRAYING MIXTURES.

CAUTION: Label all spraying materials distinctly, and mark POISON. Keep such materials out of reach of children and all animals. The formulas here given are for use on the apple, and in many cases they are not suitable for the peach or other tender plants.

FORMULA 1. LIME-SULPHUR MIXTURE.

Fresh Lime (unslaked)	20 pounds
Sulphur	15 pounds
Water	50 gallons

One of the best known remedies for San Jose scale; also an excellent fungicide. To be used only when the plants are dormant, and for the best results should be applied in early spring—March or April—before the buds swell.

For the amount mentioned, slake lime and sulphur together in a large iron kettle; dilute to 15 gallons, and boil for an hour. The liquid should then have changed to a reddish-amber color, and will be ready for use. Dilute to 50 gallons with water, and apply while hot. If more than a few trees are to be sprayed, the most satisfactory method of cooking is to use a jet of live steam and cook in barrels or a tank. Several firms offer a prepared mixture which is apparently satisfactory, but is naturally more expensive than the home made material.

FORMULA 2. SOLUBLE OILS.

Soluble Oil	1 gallon
Water	12 to 15 gallons

Preparations of "soluble oils" are often used as a substitute for the lime-sulphur mixture, and in many cases these preparations are very effective in killing the scale. They have no value as fungicides, however, and cannot be used as late in the season as can the lime-sulphur mixture, without injury to the tree. Specific directions are given with each preparation.

Among the best known of the "soluble oils," are: Target Brand, Scalecide, Kill-o-Scale, San-U-Zay.

FORMULA 3. BORDEAUX MIXTURE.

Copper Sulphate	3 pounds
Fresh Lime (unslaked)	5 pounds
Water	50 gallons

Get pure lime, well burned. Always dissolve the copper salt in a wooden vessel or earthen jar. It will corrode a tin or galvanized iron pail. For a small amount of the material, not more than a barrel, dissolve the copper sulphate in about 2 gallons of hot water by suspending it from the top of the vessel in a cloth bag; pour the solution into the tank or barrel used for spraying, and fill about half full of water. Slake the lime by the addition of a small amount of water, and when slaked add 2 or 3 gallons of water and stir freely. Pour the milk of lime thus made into the sulphate solution, passing it through a brass wire strainer of about 30 meshes to the inch (No. 50), or through a cheese-cloth backed by common window screen. Stir constantly while adding the lime. Add water to make the desired amount.

In case larger quantities of the mixture are required, the use of stock solutions of lime and copper sulphate will save much time. For this purpose, weigh out 30 pounds of copper sulphate and suspend in a bag from the top of a barrel containing 30 gallons of water. Slake 50 pounds of lime, and add water to make 30 gallons in another barrel. For use, 3 gallons of each material, with 44 gallons of water, make up the formula given above. A third barrel may well be used as a mixing tank, instead of mixing in spray-tank; but in any case, dilute the copper sulphate solution as directed, before adding the lime. The stock solutions should be kept covered to prevent evaporation, *and should be thoroughly stirred before dipping out.*

FORMULA 3a. STRONG BORDEAUX MIXTURE.

Copper Sulphate	5 pounds
Fresh Lime	5 pounds
Water	50 gallons

Prepared the same as Formula 3. For use early in spring, if the treatment with copper sulphate alone (Formula 4) has been delayed.

FORMULA 4. COPPER SULPHATE.

Copper Sulphate	5 pounds
Water	50 gallons

Dissolve the copper salt as for Bordeaux mixture. For use as a winter fungicide.

FORMULA 5. LEAD ARSENATE.

Lead Arsenate,or Disparene	2 to 3 pounds
Water	50 gallons

Lead arsenate is in many places taking the place of Paris Green as the standard insecticide, since it remains longer in suspension, does not burn the foliage, and adheres better to the leaf surfaces. Make a thin, smooth paste with the poison and a little water, then add the remainder of the water and stir thoroughly.

FORMULA 6. BORDEAUX-ARSENATE MIXTURE.

Arsenate of Lead or Disparene	2 to 3 pounds
Bordeaux Mixture	50 gallons

Make a smooth paste of the poison and a little water; add to the Bordeaux mixture and stir thoroughly. Apply at once. Paris green (½ pound) may be used in place of the arsenate of lead. This is the universally recognized formula for use as a combined insecticide and fungicide.

FORMULA 7. KEROSENE EMULSION.

Hard Soap	½ pound
Boiling Water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the water, first cutting it into thin slices to facilitate the process; remove from the stove, add kerosene, and churn through a force pump for 10 minutes. This forms a thick, creamlike stock solution. For use add 1 gallon emulsion to 10 gallons of water. For use on very young tender shoots, add 1 gallon emulsion to 15 gallons of water.

The standard formula for green lice.

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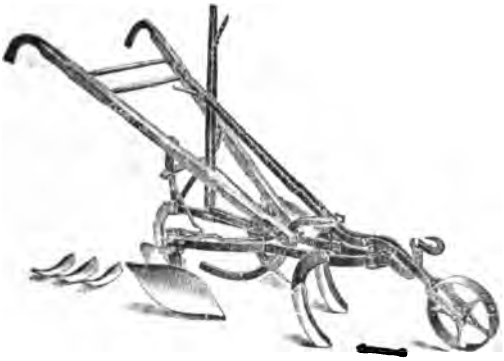
UNIVERSITY OF MICHIGAN
AUG 3 1911

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 122 MAY, 1909

The Farmer's
HOME GARDEN



By A. L. Dacy

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The last session of the Legislature appropriated money for the promotion of horticultural and trucking industries of the State. This is a very commendable undertaking by the Legislature and the duties of carrying out the work have been imposed upon the Director of the Experiment Station. Among other things, in pursuance of the Act of the Legislature, a series of bulletins upon practical subjects bearing upon horticulture and trucking will be published from time to time and this bulletin is the third of the series.

In carrying out the work the hearty co-operation of all persons engaged in trucking and in horticulture is cordially invited.

Yours truly.

J. H. STEWART.

PLANTING TABLE

Quantity of seeds or number of plants required for 100ft. of row, with distance to plant, times for planting and period required for the production of the crops. Brackets indicate that a late or second crop may be planted the same season.

Kind of Vegetable	Seeds, plants required for 100 ftr of row	Distance for Plants to Stand			Depth of Plan'g	Time of Planting in Open Ground	Ready for use after planting
		Rows Apart		Plants A-part in rows			
		Horse cul.	Hand cul.				
Asparagus; Seed	1 ounce	21-2 3 ft.	1-2 ft.	3 to 5 in.	1-2 in.	Autumn, EarlySpri'g	3to4 years
Asparagus plants	60-80 plants	3 or 4 ft.	1-2 ft.	15to20 in.	4-5 in.	Autumn, EarlySpri'g	1 to 3 yrs
Beans, bush	1 pint	21-2 3 ft.	11-2 2 ft.	4 in.	1-2 2in	Ap-May, July Aug.	40to65das
Beans, pole	1-2 pint	3 or 4 ft.	3 to 4 ft.	3 ft.	1 11-2i	Late Spring	50to80das
Beets	2 ounces	1 or 3 ft.	1 11-2 ft.	3to4 in.	I-2 1in	Apr-May, July, Aug	60to80das
Brussels, sprouts	1-4 ounce	2 1-2 3 ft	11-2 2 ft.	1 1-2 2 ft.	1-2 in.	June July	90to120da
Cabbage, early	1-4 ounce	21-2 3 ft.	2 21-2 ft.	2 21-2 ft.	1-2 in.	Apr st't seed h b. Fe	90to130da
Cabbage, late	1-4 ounce	3 ft.	2 1-2ft.	2 21-2 ft.	1-2 in.	June	90to130da
Carrot	1 ounce	21-2 3 ft.	16-18 in.	3 to 4 in.	1-2 in.	Apr May, July	75to110da
Cauliflower	1-4 ounce	21-2 3 ft.	2 21-2ft.	1 1-2 2 ft.	1-2 in.	AprJly st s'd hb F J	100to130d
Celery	1-4 ounce	3 to 5 ft.	1 1-2 3 ft-	6 in.	I-8 in.	AprJly st s'd hb FA	120to150d
Corn, sweet	1-4 pint	3 ft.	2 1-2 8 ft	12 in.	1-2 in.	May July	60to100da
Cucumbers	1-2 ounce	4 ft,	4 ft	4 ft.	1 in	May July	60to80das
Egg Plant	1-3 ounce	21-2 3 ft.	2 21-2 ft-	1 1-2 2 ft.	1-2 1in	May June	100to140d
Kale or Barecole	1-4 ounce	21-2 3 ft.	1 1-2 2 ft.	1 to 2 ft.	1-2 in.	April May, AugSept	90to120da
Kohl-rabi	1-4 ounce	21-2 3 ft.	1 1-2 2 ft.	6 in.	1-2 in.	April May, June Jly	60to80das
Lettuce	1-2 ounce	21-2 ft.	1 11-2 ft.	Los 4-6 in	1-2 in.	April June, AugSept	60to90das
Melon, Musk.	1-2 ounce	5 to 6 ft.	5 to 6 ft.	H 9-12 in-	1 in	May June	120to150d
Melon, Water	1 ounce	7 to 9 ft.	6 to 8 ft.	Hills 6 ft.	1 in	May June	100to120d
Onion, seeds	1 ounce	2 to 3 ft.	1 11-2 ft.	21-2 3 in.	12 1 in	April May	130to150d
Onion, sets,	1 qt. sets	2 to 3 ft.	1 11-2 ft.	2 21-2 in.	1 11-2i	April	90to120da
Parsley	1-4 ounce	2 to 3 ft.	1 11-2 ft.	2 to 4 in.	1-8 in	April May	90to120da
Parsnip	1-2 ounce	21-2 3 ft.	1 1-2 2 ft.	3 to 4 in.	1-2 1in	April May	125to160d
Peas	1-2 pint	3 to 4 ft,	21-2 3ft.	2 in	2to3in	April May, JulyAug	50to80das
Pepper,	1-8 ounce	21-2 3 ft.	1 1-2 2 ft.	15to 18 in	1-2 in.	May June	100to140d
Potato, Irish	5 pounds	21-2 3 ft	2 to 3 ft.	12to15in.	4to6 in	March May	80to140da
Potato, Sweet	3 pounds	3 to 5 ft.	3 to 5 ft.	14 in.	3 in	April May	140to160d
Pumpkin	1-2 ounce	6 to 8 ft.	6 to 8 ft.	Hills6-8ft	1 11-2i	April May	100to140 d
Radish	1 ounce	2 to 3 ft.	1 11-2 ft.	11-2 2 in.	1-2 in.	March September	20to40das
Rhubarb, plants	33 plants	3 to 5 ft.	3 to 5 ft.	3 teet	2to3 in	AutumnEarly Spri'g	1to3 years
Salsify	1 ounce	21-2 3 ft.	11-2 2ft.	2 to 4 in.	1 2 in.	April May	120to180 d
Spinach	1 ounce	21-2 3 ft.	1 11-2 ft.	2 to 4 in.	1 in	March September	30to60das
Squash, summer	1-2 ounce	3 to 4 ft.	3 to 4 ft.	Hill 3-4ft.	1 1-2in	April May	60to80das
Squash, winter	1-2 ounce	7 to 9 ft.	7 to - ft.	Hill 7-9ft.	1 1-2in	May June	120to160 d
Tomato	1-8 ounce	3 to 5 ft	3 to 5 ft.	21-2 3 ft.	1-2 in.	MayJ'e st pts hb F M	100to140 d
Turnip	1-2 ounce	2 tn 3 ft.	2 to 3 ft.	3 to 4 in.	1-4 1-2	April July	60to80das

Adapted from Farmer's Bulletin No. 255.

THE FARMER'S HOME GARDEN

That the majority of the farmers of West Virginia are not getting the largest possible return from their home garden is apparent to anyone who has the opportunuity to observe the results obtained at present, who is acquainted with the possibilities of profit in cultivating an acre of ground, or who knows the present condition of the markets in our cities and towns with regard to the supply of fresh fruits and vegetables.

The limit to the possible income from an acre of ground, is as yet an undetermined quantity, but in a large measure it is proportionate to the amount of skill and labor bestowed upon it. It is easily possible, however, for any farmer to make his home garden the best paying area on his farm.

In the spring of 1900 the Agricultural Experiment Station of Illinois set apart one-half an acre of land and for five years treated it as a "farmer's vegetable garden." "The object of maintaining this garden was to secure data regarding the cost of such a garden and the value of its products, and to demonstrate the feasibility of securing a large assortment and continuous supply of vegetables throughout the year by a proper selection of varieties, timely planting and judicious tillage."

"Each year an accurate record was kept of all labor involved in the planting and care of the garden as well as the cost of the seeds, etc., so that the cost of the garden for each year could be determined. No charge was made for the rent of the land, nor for the manure, except the hauling. Neither was any charge made for the time spent in gathering the vegetables, for in practic they would be gathered from one to three times a day, as needed for the table, and usually by those doing the kitchen work, rather than by the farmer himself. In all cases an accurate account was kept of everything gathered from the garden. At the end of the season the garden was credited with these products at a fair, average price. The prices were based upon those ruling in the local market at the time the different vegetables were gathered."

"The average value of the products per year for the five years was $105.23, and the average net profits $74.85."*

"From careful observation the statement can safely be made that a well kept garden will yield a return ten to fifteen times greater than would the same area if devoted to general farm crops. A half acre devoted to the various kinds of garden crops will easily supply a family with $100 worth of vegetables during the year, while the average return for farm crops is considerably less than one-tenth of this amount."**

With the keen demand for fresh fruits and vegetables which exists in our home markets, a demand which to a large degree is supplied from sources outside of the state, the home gardens of West Virginia should not only supply their owners with the best of a living, for a large portion of the year, but should be a source of considerable revenue as well.

LOCATION OF THE GARDEN.

In choosing the location of the home garden it is well to keep in mind the fact that from force of circumstances, much of the work in the garden will be done in spare moments, and by the women and children of the household. It should therefore be as convenient to the house as possible. Best results will be obtained from a fairly level, well drained, light, sandy loam, with a southerly exposure. The ideal soil or exposure is not always at hand, however. Choose the best site possible and by correct management its defects may be remedied.

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*Illinois Agricultural Experiment Station Bulletin 105.

**Farmers Bulletin 255, U. S. Dept. Agr., Page 5.

PREPARATION OF THE SOIL.

If the soil of the garden is a clay which is wet in the spring and bakes in the summer, tile drainage will benefit it greatly. If this is not done, it should receive a liberal application of strawy barnyard manure and be plowed deeply in the fall, exposing the furrows to the beneficial action of the freezing and thawing of the winter months. Subsoiling will be found advantageous in most cases. If a sandy loam, it is well to manure the garden in the fall or winter months, but the plowing may be left until spring. The judicious use of lime will be a help in improving defects of soil in the garden. It will correct acidity, render more compact, soils that are too sandy and make clay soils more open and friable. The garden should be plowed as early in the spring as the ground is dry enough, and should be put into condition for planting by being thoroughly pulverized with the harrow and leveled, with a plank drag.

FERTILIZERS.

There is probably no better fertilizer for use in the home garden than well-rotted barnyard manure. There is not much danger of using it too freely. If the home supply is not abundant enough, it may be supplemented by using a high grade commercial fertilizer with a guaranteed analysis of three per cent nitrogen, eight per cent phosphoric acid and ten per cent potash. This may be used as a top dressing after plowing, at the rate of one thousand pounds to the acre, to be harrowed in, or it may be mixed with the soil in the furrow or hill just before planting. The manure from the fowls of the farm is especially adapted for use in the hill or furrow where it will be quickly available to the plants. Nitrate of soda is a valuable aid in hastening the growth of asparagus, rhubarb, lettuce, spinach and other early crops, as it supplies nitrogen in a quickly available form. It is best to use it in two or three applications at the rate of one hundred pounds to the acre.

PLANNING THE GARDEN.

It is grave mistake to wait until the rush of spring work is on before giving thought to the management of the garden. The comparative leisure of the winter months should be improved by planning the garden for the coming season. If a diagram is made of the garden showing the location of the prospective crops and the succession plantings it will bring to mind many important details which might otherwise be forgotten, and will save time when it counts for the most.

SUCCESSION OF CROPS.

It is the purpose of every good gardener to make his land produce as much as possible. As soon as one crop is matured he plans either to plant the seed of another crop in its place or to have the plants partly grown to succeed the first crop. By judicious management even three crops may be taken from the same piece of ground in a season. The following are suggestive: The old strawberry bed may be manured and plowed up after fruiting and set with cabbage, cauliflower or celery plants which have been started in a hot-bed or cold frame. Early peas may be followed by seeds of beets, carrots or beans, or by plants of celery or tomatoes; radish or bunch onions, by cabbage or celery. Early lettuce, beets, carrots or beans, may be followed by later crops of the same; early potatoes by late cabbage, cauliflower or celery; and early cabbage by spinach or late beans.

LOCATION OF CROPS.

In determining the location of the various crops in the garden the following considerations are suggested.

The small fruits and perennial vegetables should be placed in a part by themselves, where they are to remain from year to year.

A new strawberry bed should be started each year and after fruiting two years, be discarded.

The rows of vegetables should be made long and far enough apart to permit of horse cultivation except in the case of such varieties as can and should receive better care, and yield larger returns, from a smaller area if cultivated by hand.

Varieties which mature at about the same time, should be planted near together, so that their place may be taken by a succession crop. The different varieties should also be arranged as nearly as possible in the order of their planting so that the unplanted portion of the garden may be kept stirred to prevent weeds from growing and to conserve the moisture until ready for planting.

A sample plan for a home garden of one-half an acre is given on pages 386 and 387. This plan embodies the suggestions mentioned above.

SEEDS FOR THE GARDEN.

Seedsmen's catalogues should be consulted, and orders should be placed for seeds, tools and fertilizers needed, a good while before planting time arrives so as to avoid annoying delays. Buy only the best seeds from a reliable seedsman. By so doing a stock of superior strains will be secured, free from weed seeds, and of strong vitality, which will insure a full stand of plants. It is poor economy to invest in cheap seeds. To aid in ordering seeds for the garden, the amounts of seeds needed to sow one hundred feet of row are given in the planting table, on page 372. A list of suitable varieties of small fruits and vegetables follows. This list is merely suggestive, but it contains varieties which have been tested and found satisfactory:

Currants—Wilder, Perfection, Fays Prolific, White Imperial; *Gooseberries*--Downing; *Red Raspberries*—Marlboro, Cuthbert; *Black Raspberries*—Kansas, Cumberland; *Blackberries*—Early Harvest, Snyder, Eldorado; *Strawberries*—Clyde, (Per.) Haverland, (Imp.) Parson's Beauty, (Per.) Glen Mary, (Per.) Senator Dunlap, (Per.) Brandywine, (Per.) Dornan, (Per.) Sample, (Imp.) (Varieties marked "Imp." are pistillate and should be planted between varieties marked "Per."); *Asparagus*—Palmetto, Conover's Collossal; *Bush Beans*—Giant Stringless, Refugee, Wardwell's Kidney Wax, Early Carmine Podded Hort.

Bush Lima Beans—Henderson's, Dreer's, or Burpee's; *Beets*—Eclipse, Crosby's Egyptian, Detroit Dark Red or Edmand's Blood; *Early Cabbage*—Early Spring, Early Jersey Wakefield, Henderson's Early Summer;*Late Cabbage*—Stone Mason, All Seasons, American Savoy; *Carrots*—Early Scarlet Horn, Danvers, Chantenay;*Cauliflower*—Snowball, Erfurt; *Celery*—Paris Golden, Giant Pascal; *Sweet Corn*—Cory, Lackey, Early Crosby, Potter's Excelsior, Quincy Market, Country Gentleman, Stowell's Evergreen; *Cucumbers*—White Spine, Emerald; *Egg Plant*—N. Y. Imp. Purple; *Kale*—Scotch Curled; *Kohl Rabi*—Early White Vienna; *Lettuce*—(Forming heads), Black Seeded Tennis Ball, Hanson; (Loose Leaved,) Early Curled Simpson, Grand Rapids; *Muskmelons*—Netted Gem or Rocky Ford; *Onions*—Yellow Danvers, Prizetaker; *Parsnips*—Abbott's Hollow Crown, Imp. Guernsey; *Peas*—Alaska, American Wonder, Gradus, Telephone; *Peppers*—Ruby King, Sweet Mountain, Large Bell; *Potatoes, Irish*—Noroton Beauty, Early Ohio, Early Rose, Delaware, Green Mountain; *Potatoes, Sweet*—(Dry Mealy Fleshed,) Yellow Jersey, (Moist Fleshed), Georgia, Florida and Red Bermuda; *Pumpkin*—Sugar; *Radishes*—Early Scarlet Globe, French Breakfast, Early Frame; *Spinach*—Early Giant Thick Leaved; *Squash*—(Summer) Strickler's Crookneck; (Fall) Boston Marrow; (Winter), Essex Hybrid, Delicious, Hubbard; *Tomatoes*—Earliana, Stone, Perfection; *Turnip*—Early White Milan, White Egg. Early Am. Red Top; *Watermelons*—Dark Icing, Dixie, Florida Favorite, Kolb Gem. As far as possible the above varieties are arranged in the order in which they mature.

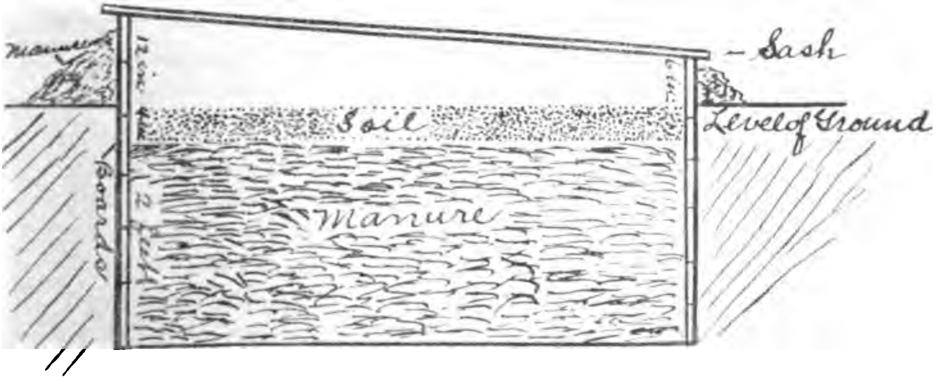
PLANTS FOR THE GARDEN.

The season for enjoying fresh vegetables may be lengthened at both ends, and the garden area made to produce a larger profit if hot-beds or cold frames are used for starting plants of such vegetables as radish, lettuce, cabbage, cauliflower, tomato, celery, egg plant, pepper, etc. The latest sowing of radish and lettuce may be matured in the frames. Hot-bed sash should not cost more than two dollars apiece, and the farm wood lot should furnish the material for the frames. They should be placed in the lee of a building or other sheltered place and the glass should face the south.

CONSTRUCTION OF HOT-BEDS AND COLD FRAMES.

To construct a hot-bed, excavate the soil, making a pit about two and one-half feet deep, six feet wide and long enough to accommodate the number of sash to be used. Standard hot-bed sash are made three feet wide by six feet long. Line the sides and ends of the pit with one and one-half or two inch plank, nailed to chestnut or locust stakes. If the ground is level the frame should extend twelve inches above the ground on the upper side and six inches on the lower side, to allow the water to drain from the glass. Cross bars of two by three inch material should be placed at intervals near enough to insure proper stiffness of the frame.

Some time before the hot-bed is to be used, fresh horse manure containing a liberal amount of straw should be spread evenly in the bed, tramping it compactly until the pit is full to within about six inches of the top on the lower side of the frame. The manure will settle several inches before it is time to sow the seed. Put the sash on the frame after filling and allow the manure to heat for a few days. The temperature will rise quite high but should be allowed to fall to about 80° F., when about four inches of good garden loam should be spread evenly on top of the



manure. The outside of the frame should be banked with soil or strawy manure to help retain the heat in the frame. Fig. 1 gives a cross section of the hot-bed when it is ready for use.

A cold frame is similar to the hot-bed except that the only heat obtained is that furnished by the rays of the sun through the glass sash. It is constructed of lighter material, one inch boards being stout enough. A twelve inch board is used in back and an eight inch board in front, and the frame is placed on top of the ground. In the northern part of the state the cold frame may be used for hardening off plants which have been started in the hot-bed, previous to setting them in the field. In the southern part of the state it may take the place of the hot-bed. Whichever style of frame is used, it is well to have at hand some old blankets, burlap bags, or straw, which may be thrown over the frame at night to protect it from the cold.

PLANTING AND CARE OF HOT-BEDS .

The seeds may be sown directly in the soil over the manure or in boxes, called "flats". These can be made from the various sized packing cases which may be obtained from the grocery store. Boxes twelve to fifteen inches wide by fifteen to eighteen inches long are a convenient size to handle. The box should be sawed into horizontal sections about three inches deep, the cover of the box or any thin boards being used for the bottom of the sections other than the lower one of the box. The advantage of using the boxes is in the fact that the seed sowing and transplanting may be done in the house or any other shelter, when the weather would not permit of their being done in the frame.

In either case the seed bed should be made firm and level, and the seed sown in straight lines, about two inches apart, made by pressing the edge of a narrow stick such as a lath, into the soil to the required depth. Scatter the seeds fairly thickly in the depression thus made. Then level and compact the soil with a smooth board and water the bed or box. If boxes are used they should be placed on top of the soil in the frame, taking care that the surface of the soil is level.

After the seeds come up, the frame will need ventilation on bright, sunny days. This is done by raising the sash a few inches on the opposite side from the wind, and holding it in place with a block of wood. The sash should be lowered again in time to allow the frame to become warm enough to carry it safely through the night. Watering should be done only on bright days, and early in the day. The sash should be raised to allow the foliage and the surface of the ground to dry off. If the soil is allowed to become too wet, the young plants are apt to be lost through the attack of the "damping off" fungus.

The young plants should not be allowed to grow too thickly and become "leggy," but should be thinned out enough to produce strong, stocky plants. An occasional stirring of the soil will be a great help in hastening their growth.

HANDLING THE PLANTS.

Before setting in the open field, plants which have been grown in the hot-bed or cold frame will need to be "hardened off." That is, they should become gradually accustomed to the effect of sun and wind, so they will stand the change of transplanting to the open ground. To do this the amount of vntilation given should be gradually increased until the frames can be left uncovered during the entire day and upon warm nights. The amount of water given should be decreased to just enough to keep the plants from wilting.

TRANSPLANTING.

When the seedlings begin to show the third or fourth leaves of fair size, they should be transplanted to about two inches apart each way, either in the beds or in the "flats." When they begin to crowd again they should be ready to set in the garden. Such plants as cucumbers, melons and beans, which do not transplant readily from seed bed to garden, may be grown in soiled strawberry baskets, or on inverted pieces of sod, planting enough seed for one hill in each sod or box.

Before transplanting to the open ground, the soil containing the plants should be thoroughly soaked, so that in lifting them, a portion of the soil will adhere to the roots. The soil of the garden should have been previously prepared to receive the plants so that the work of transplanting may be quickly done. It is best to choose a cloudy day, or one when rain seems likely to come soon. If in a dry time, it is best to set the plants at evening. The soil should be thoroughly compacted about the roots of the plants when set and the soil on top left loose around the plants to prevent the escape of moisture.

PLANTING OF THE SEEDS.

The time for planting seeds in the garden, also the depth and distance apart at which they should be placed, is given in the planting table on page 372. The time given is approximate, as it will vary with different seasons and in different parts of the state. The ground for the garden having been thoroughly fitted, the rows may be laid out in straight lines by means of a home-made sled marker, which will mark two or three rows at a time. If a seed drill is used, it is only necessary to get the first line straight, as the marker attached to the drill indicates each succeeding row.

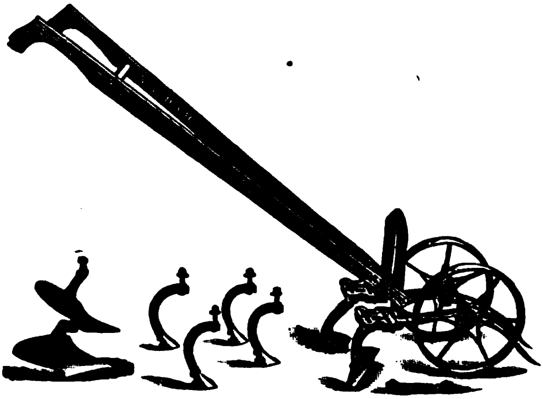
CULTIVATING THE GARDEN.

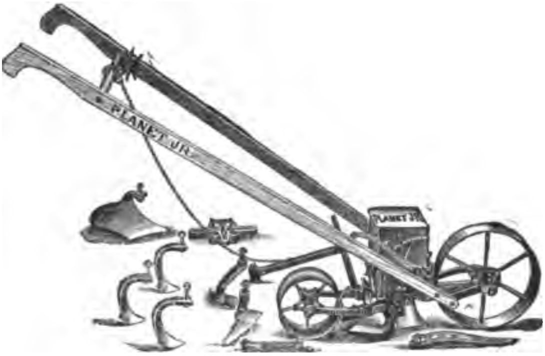
If the rows are marked, cultivation may begin before the plants appear. It should be kept up at frequent intervals throughout the growing season, not only to destroy weeds, but to conserve the moisture in the soil by maintaining a dust mulch and to liberate plant food by breaking up the soil particles. The crust which is formed by heavy rains should be broken as soon as the soil is dry enough to work.

TOOLS FOR THE GARDEN.

Money spent for the proper kind of tools for the garden is well invested since they reduce the cost of its care and enable the farmer to grow larger and more profitable crops. Aside from the plow, harrow and drag, which are needed in fitting the land for any farm crop, some of the tools most useful in the garden are:

seed drill, a horse cultivator, a spading fork, trowel, steel rake, wooden lawn rake, hand weeder, scuffle hoe, common hoe, watering can, wheelbarrow and wheel hoe. A good outfit of tools for the garden should be bought for from $25.00 to $35.00.

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PLANET JR.

INSECTS AND DISEASES.

The discussion of insects and plant diseases which attack garden crops will be left for future bulletins. It is well to remember, however, that prevention is in many cases easier than cure. A great deal may be accomplished in controlling these pests by clean cultivation, by burning all rubbish and diseased plants, and by a rotation of crops, whereby the relative position of the different crops in the garden is changed from year to year.

MARKETING THE SURPLUS.

As was intimated at the beginning of this bulletin, the markets of our cities and towns are obliged to buy a large share of their produce from sources outside of the state. With very little extra effort the farmers of West Virginia could supply a large share of this trade. Each farmer should study the condition of his nearest market, find out the kinds of vegetables and fruits most in demand and plant heavier of these varieties than he needs for his own use. He should find out the way in which his market demands they should be prepared for sale, and be sure that his products reach their destination in a clean, fresh and attractive condition. Attention to these points will insure a ready sale at renumerative prices.

CANNING THE SURPLUS.

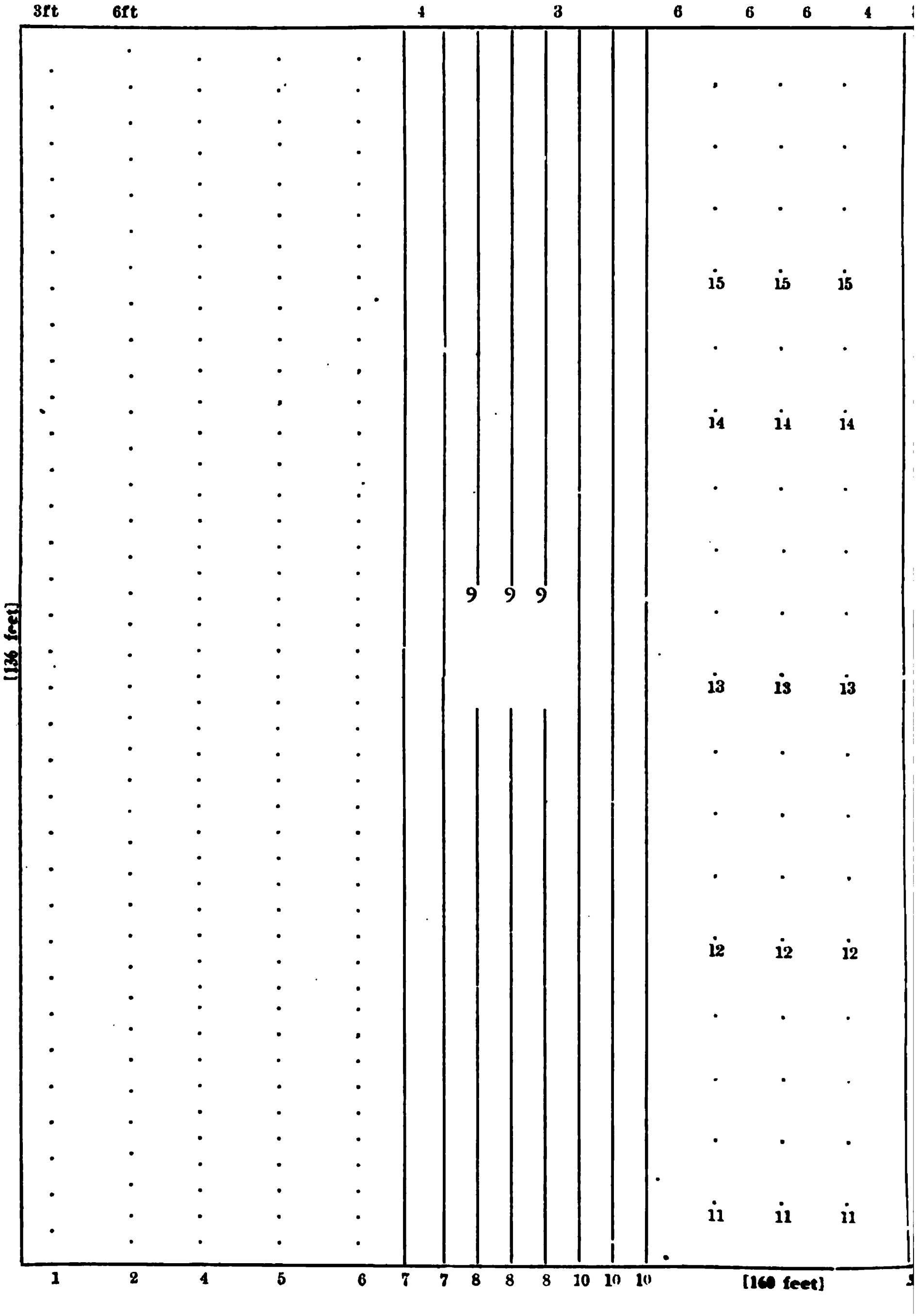
With the several excellent makes of low-priced canning outfits now on the market there need be no waste of the products of the farm garden. Any surplus of berries and of almost all kinds of vegetables may be canned, for use at home during the winter or for sale in this form. Receipts for preserving fruits may be obtained by sending for Farmers' Bulletin 203—Canned Fruits, Preserves, and Jellies. Directions for canning the various vegetables are furnished by the manufacturers of canning outfits, such as the Modern Canner Co., Chattanooga, Tenn., the Farm Canning Machine Co., of Meridian, Miss., and E. G. Mendenhall, Kinmundy, Ill., agent for the Ranney Canner Co.

STORING VEGETABLES FOR WINTER USE.

Many of the vegetables of the home garden may be kept in their natural state till well along toward spring if given the proper amount of care. A good cool cellar affords an excellent means for storing most varieties of garden crops. The method of treatment best suited to each crop will be discussed in the following pages.

Explanation of The Diagram

Row	Kind of Fruit or Vegetable
1	Currants
2	Goosberries
3	Rhubarb
4	Red Raspberries
5	Black Raspberries
6	Blackberries
7	Asparagus
8	Old Strawberry Bed
9	New Strawberry Bed
10	Sweet Corn with Field Beans between after 2nd cultivation.
11	Muskmelon
12	Watermelon
13	Cucumbers
14	Pumpkins
15	Winter Squash
16	Peas. 1-3 early, 1-3 med. 1-3 late. Early Peas followed by late beans
17	Early Cabbage followed by late celery.
18	Cauliflower. (early) followed by late Beans.
19	Early Potatoes followed by late Cauliflower
20	One-half row Kale, one half row Brussels
21	Bush Beans, Green, Wax Lima and Horticultural
22	Sweet Potatoes
23	Early Celery followed by fall Spinach.
24	Tomatoes
25	Late Cabbage
26	Pole Beans
27	Radishes
28	Spinach
29	Lettuce
30	Early Carrots
31	Onion Sets
32	Beets
33	Kohl Rabi
34	Turnip
35	Summer Squash
36	Onion Seed
36A	Egg Plant
37	Peppers
38	Late Carrots
39	Parsley
40	Salsify
41	Parsnips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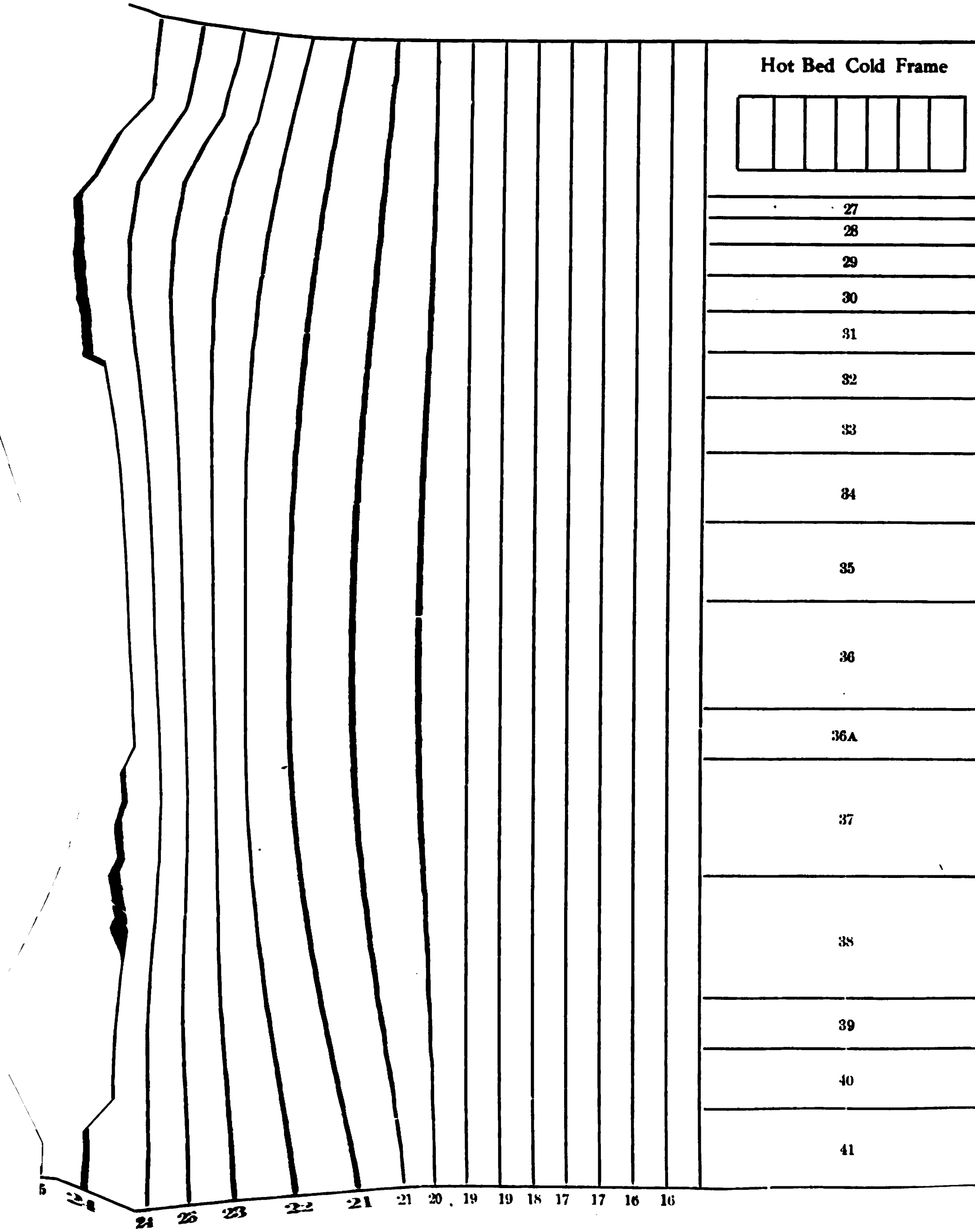
Hot Bed Cold Frame

CULTURAL HINTS FOR FARM GARDEN CROPS

ASPARAGUS.

Every farm garden should have its asparagus bed. This vegetable is one of the earliest to be ready for use when the products of the garden are eagerly awaited. It prefers a light sandy loam, and responds readily to liberal feeding. When once planted an asparagus bed is good for fifteen or twenty years. The initial preparation should therefore be thorough. The plants may be raised from seed, but it is better to buy strong two-year old roots from a seedsman or nurseryman. They may be set either in the fall or early spring. The land where they are to be planted should be heavily manured and plowed deeply. To prepare the bed for setting, furrow out the rows about six inches deep, about four feet apart and set the plants in the bottom of the furrows, about fourteen inches apart and cover firmly with about four inches of soil. The furrows will become filled with subsequent cultivation. Apply about two inches of manure as a top dressing each fall and work it into the soil as early in the spring as possible. If two-year-old roots are planted a light cutting may be made the second season after planting, and each succeeding year should give a full crop. If the asparagus is preferred bleached, the bed should be slightly crowned in the spring and the shoots cut several inches below the ground, soon after they appear, being careful to put the knife straight down beside the shoots to avoid cutting others which cannot be seen. If to be had green, all that is necessary is to break off the tender roots at the surface of the ground as soon as they have reached the desired length. During the cutting season, which will last from one to two months, all shoots, large or small, should be removed. When the shoots become tough and stringy, cutting should cease.

The bed should then be fertilized and cultivated well until fall, as the better the growth made during this part of the year, the better will be the following spring's crop. After the tops die in the fall, remove and burn them. The surplus product of the bed will find ready sale at good prices wherever this vegetable is known. It is sold in bunches weighing about a pound. If desired the tender tips may be canned, affording a delicacy for the winter table.

BEANS.

Beans do best on a warm sandy loam, but may be grown on almost any garden soil. They may be divided into two classes, bush and pole beans, and each class may be subdivided into green, wax, lima and shell beans. They may therefore be had in a pleasing variety, and by making successive plantings a continuous supply may be enjoyed from early summer to late fall.

Beans should not be planted in quantity until the ground is thoroughly warmed, although a few bunch beans may be risked as soon as the ground can be worked.

Pole beans require somewhat richer soil than bush beans, and while the labor of preparing and setting the poles is considerable, they are superior to the bush sorts in quality.

Lima beans, both bush and pole, require a rich soil and should not be planted until later than the bush beans.

For the production of dry beans for winter use, varieties such as Red Kidney, White Kidney or White Marrow should be planted about the middle of the summer. The surplus of the later planting of snap beans may be dried by pulling the vines before frost and piling in small piles about poles.

The later plantings of bush string beans may follow an early crop of radish, lettuce, beets, carrots, etc.

BEETS.

The garden beet will grow in any good corn land, but gives best results in a rich, sandy loam. Seeds may be sown as early as the ground can be worked, in drills twelve to eighteen inches apart and later thinned to about three or four inches in the row.

If planted in rows three feet apart, for horse cultivation, they may be sown in a double row with six inches between, leaving thirty inches for cultivation. For a supply of young, tender beets, succession sowings should be made at intervals of four or five weeks during the summer months. The crop intended for winter use should not be planted before July. Before too severe freezing weather the beets should be pulled, topped and covered with earth in piles in the field or with moist sand in the cellar.

BLACKBERRIES.

Blackberry plants may be set in the fall or early spring. They should receive frequent cultivation during the first season after planting, and the canes should be pinched back when they reach about three feet in height. The following spring the lateral branches should be shortened to about one foot in length. The plants should be kept down to a narrow hedge-row and thinned to stand about a foot apart.

BRUSSELS SPROUTS.

Require care similar to that given the cabbage except that they may be grown somewhat closer together. The parts eaten are the little cabbage-like growths which appear at the axils of the leaves. They seldom reach a diameter exceeding two inches. As the heads begin to crowd, the leaves should be broken from the stem of the plant in order to give them more room, leaving a few at the top where the new heads are being formed.

They are cooked the same as cabbage but are considered superior in flavor to the cabbage. Brussels Sprouts are very hardy and are improved by freezing. They may be left out all winter if given some protection, or may be pulled when hard freezing weather sets in, and stood upright in the cellar with some soil about the roots, or in a pit which may be covered with straw.

CABBAGE.

For the early crop of cabbage, seed may be sown in the hotbed or cold frame about the first of February, and transplanted when the seedlings show the third or fourth leaf. They should be hardened off and ready to transplant to the open ground about the first or middle of April. The early crop may be followed by late beans, spinach, beets or carrots.

Plants for the late crop may be secured in a similar manner by planting the seed in May or June and transplanting to the field in July. Or the field may be marked off in June, three feet each way and several seeds planted at each intersection. The plants should be thinned to the most vigorous one when a good stand is assured. The advantage of starting the plants in the bed are: It makes possible the use of the larger area they would occupy in the field, for maturing one crop to be followed by the cabbages when the ground is cleared of the first crop. It is easier to care for the young plants in the bed. It saves in the labor of cultivating, which would be necessary if set in the field. Its disadvantage lies in the fact that when the plants should be transplanted to the field, the weather is apt to be hot and dry and unless great care is taken in the operation, the plants are likely to die or receive a severe check. Cutting off one-half to two-thirds of the leaf surface at transplanting is often of great advantage—especially in a dry time. Cabbages may be left in the ground unutil severe freezing weather. They should then be pulled and the heads set in a trench with the roots up and covered with about six inches of soil and enough mulch to keep the cabbages from freezing.

CARROT.

By planting seeds of the Early Scarlet Horn variety in the frame, and again in the open ground as soon as it is fit to be worked and by following this variety with Danvers and Chantenay ,a long season of this vegetable may be enjoyed. For the winter crop it is best to sow the seed not earlier than the first of July. Carrots should be left in the ground until severe freezing weather, when they should be dug, topped and covered with moist sand in the cellar or covered with soil in piles in the field.

CAULIFLOWER.

Like the cabbage, the cauliflower is grown as an early spring crop and as a fall crop. It is more delicate than the cabbage and is somewhat more difficult to grow successfully. The best seed obtainable should be used, as much depends upon the quality. The plants for the early crops should be started as for cabbage, transplanting once and taking care that they receive no check in their growth at any time. They may be set somewhat closer than the cabbage. When the heads begin to form, the leaves should be drawn together in order to secure a white even color. Exposure to the sun for any length of time spoils the heads for market. If successfully grown the cauliflower is a delicious vegetable and almost always sells readily for a good price. It will not stand freezing like the cabbage, but should be pulled and stored in the barn cellar by standing upright in some soil.

CELERY.

This crop is produced to perfection in the deep alluvial soils of certain sections of the country where swamp or lowlands have been drained. It can be grown of fine quality, however, in any deep, rich garden soil. There are glade lands in many parts of this state which when once drained would be admirably adapted to the culture of this crop. Celery seed is very small and rather difficult to germinate. Fresh seed should be obtained each season as it soon loses its vitality. The seed-bed should be made very fine and the seed should be covered very lightly—not more than an eighth of an inch. To prevent the soil from drying out (which should not be allowed) the seed-bed should be shaded with newspaper or cheese cloth. This covering should be removed as soon as the plants come through the soil. Avoid watering the young plants so freely as to cause them to damp off. Celery is benefitted by transplanting at least once before the final change to the field. When the seedlings are about a month old they should be transplanted to about one and a half inches apart. When transplanting to the field it is generally advisable to shear off part of the tops. They are set about six inches apart in rows from three to four feet apart, usually on ground which has produced a crop of early potatoes, radishes, beets, etc. It is necessary to blanch this crop. In the case of the early, or self-blanching varieties this is usually done by placing two boards, one on either side of the row, close to the plants. But few leaves are allowed to come above the tops of the boards, which are held in place by cleats nailed across the row at intervals. The bleaching may be done by ''handling'' the plants, as the operation is termed. When the plants have attained a good size the stalks are drawn closely together with the hands and soil is placed against either side of the plant. Another and final handling is given about two weeks before the celery is to be dug, when the plants are banked with soil until but a few leaves are left uncovered. Care must be taken that the soil does not fall down inside the crown of the plants. The portion of the crop that is to be used during the early part of the winter may be left in the ground and covered with straw to keep it from freezing. If it is to be kept until late in the winter, however, the celery should be dug and placed close together in a well-drained trench, which can be covered with boards, which in turn should be covered with soil and mulch, to keep from freezing. It may also be kept in a cool cellar by standing the plants upright in a few inches of soil. Spaces should be left at intervals between the rows of plants to afford ventilation.

SWEET CORN.

This is a crop which may be profitably grown by almost any farmer who is within reach of a market, for any surplus which cannot be disposed of profitably there, will make excellent feed for the stock on the farm. A succession should be had either by frequent plantings or by planting at the same time several varieties which mature in different periods of time. For the latest plantings an early variety should be used. In field culture, corn is largely grown in hills, but in the farm garden, it is better to plant in drills about three feet apart, thinning to one foot apart in the row, giving level culture.

CUCUMBERS.

An early supply of this table delicacy may be had by starting a few vines in the hot-bed or cold frame, to mature there or to be transplanted to the open ground when the weather becomes warm enough. They succeed best upon a sandy loam. To combat the striped cucumber beetle, sprinkle the young vines with air slaked lime or cover with frames over which fly screen or mosquito netting has been placed. In order that the vines may be kept in good bearing condition, no fruit should be allowed to ripen on the vines. For pickling cucumbers a few vines of some such variety as Everbearing or Boston Pickling may be planted in July.

CURRANTS.

For the currant plantation, strong one or two-year-old plants should be planted in the fall or early spring. They should begin bearing in one or two years. Their care consists of cultivation during the growing season, mulching with manure in the fall, and the removal of canes which are more than three or four years old. The growth of the young shoots, which bear the best fruit, should be encouraged. The currant worm, which is apt to be troublesome, is easly controlled by spraying the bushes with Paris green, arsenate of lead or hellebore as soon as the worms appear.

EGG PLANT.

The culture of this vegetable is similar to that of the tomato. The seeds are difficult to germinate and should be sown in the soil directly over the manure of the hot-bed. They should not be planted in the field until real warm weather.

GOOSEBERRIES.

The treatment given the currant applies with equal force to gooseberry. Both of these berries succeed best in a cool, rather shaded situation, and for this reason are often planted in the rows of pear or plum trees. The currant worm also attacks the gooseberry and is controlled in the same manner as on the currant. The fruit of the gooseberry is usually picked in the green state, as soon as the berries reach good size. The bushes will need an occasional thinning to make picking easier and to secure finer fruit.

KALE.

Kale is a vegetable of the cabbage family, the leaves of which are used as greens during the fall, winter or spring. It is very hardy. The seeds may be sown in September and the young plants protected through the winter with a covering of leaves or straw, or they may be planted in the early spring the same as cabbage. As its flavor is improved by frosts, the plants may be left in the ground through the winter with a light protection of straw.

KOHL RABI.

Kohl Rabi is not grown as extensively as its value warrants. Its culture in the seed bed is similar to that of the cabbage. It may be grown, however, without transplanting, sowing the seeds in drills as soon as the ground can be worked, and thinning to about six inches in the row. The edible part is the swollen stem which appears just above the ground. Successive sowings should be made, since it becomes hard and woody soon after it reaches a diameter of two or three inches. It is prepared for the table the same as turnip, which it resembles in flavor.

LETTUCE.

Lettuce thrives best in a rich, sandy loam containing plenty of organic matter. Many gardeners simply sow the seeds broadcast and use the leaves as soon as they become large enough. This method would hardly satisfy one who had acquired a taste for the crisp, tender product which may be obtained with a little more effort. To obtain the best results, the seed should be sown in the hot-bed or cold frame, and in about two weeks the seedlings should be transplanted to two inches apart each way. When they begin to crowd they should be transplanted again to from ten to twelve inches apart each way, according to the variety and season of the year. The plants should be kept growing rapidly by frequent cultivation and by supplying water if necessary. During the hot summer months lettuce is apt to bolt and run to seed even if the plants are shaded. It is better, during this season of the year to grow varieties like White Paris Cos (called Romaine). During July and August, seeds of the former kinds may be sown, to mature in the cool months of the fall. The earliest and the latest crops may be matured in the hot-bed or cold frame, thus lengthening the season. Plants started in the late fall may be carried over winter if given sufficient protection.

MUSKMELON AND WATERMELON.

The culture of these vegetables is similar to that given the cucumber, except that the watermelon should be planted further apart—from six to eight feet.

ONIONS.

An early crop of onions may be secured in several ways. Sets of the Multiplier or Potato onion, or bulblets of the Top or Tree onion, if planted in the fall, will give early green onions. The more common way of producing the bunch onions of early spring is to plant as early as the ground can be worked, white onion sets, which may be obtained of any seedsman. The sets are produced by sowing onion seed very thickly during the latter part of the previous summer. If desired, either white or yellow sets may be allowed to remain until they have matured, which will be earlier than the crop grown from seed. For the main crop the seed may be sown in drills one foot apart and later thinned to about two inches apart in the row. It is hardly possible to get the seed-bed in too rich or too fine a condition. In fact, "as fine as an onion bed" expresses the standard of good preparation of the soil for planting. If the onions continue growing too late in the season, maturity may be hastened by rolling a barrel over the tops, lengthwise of the rows. When the tops have become dry the onions should be carefully raked up into narrow windrows, with a wooden rake, and allowed to dry. When well dried the tops should be twisted off, and the onions put into crates or bags and stored in a dry, cool place.

PARSLEY.

Parsley is grown for its leaves, which are used for garnishing meats or for flavoring soups. Its use in the home garden will perhaps be limited to a few plants, unless it is situated in the vicinity of a good-sized market. The seed may be sown in early autumn and the plants carried over winter by protecting with straw; it may be sown early in the hot-bed or cold frame and transplanted into rows one foot apart, and about six inches apart in the row; or it may be sown early in the open ground where it is to remain, and later thinned out in the row. The seed is rather slow to germinate and should be soaked in warm water for a few hours before planting, and the soil compacted firmly over it when planted.

PARSNIP.

Parsnips should be planted in a deep loamy soil in order to secure long, smooth roots. The seed should be sown in drills, about one-half an inch deep, and the plants thinned to about three inches in the row. The roots may be dug late in the fall and stored in a cellar or pit covered with sand or soil, to prevent withering, or they may be left in the ground and dug in the spring. If the roots are left in the ground over winter it is best to use a variety which does not have the depression around the crown of the plant. The hollow crowned sorts are apt to rot because of the freezing and thawing of the water which collects in the depression.

PEAS.

For the extreme early crop, smooth peas of the Alaska type may be planted just as soon as the ground can be worked in the spring. They are much inferior to the wrinkled sorts, some of which are but a few days later in maturing. By making frequent plantings, or by planting early, medium and late varieties at the same time, a succession of this delicious begetable may be obtained. During the hot summer months peas do not do so well as earlier, on account of the mildew which attacks the vines. Plantings may be made in July or August, however, of early maturing varieties, to furnish picking in the fall months. Dwarf varieties, such as the American Wonder, may be grown without support, but for tall varieties of the Telephone type, some kind of support should be furnished for the vines. This may be brush, which has been cut before growth starts in the spring, or it may be supplied by the use of three or four foot poultry netting.

PEPPERS.

The culture of peppers is very similar to that given the tomato. It may be grown as a succession crop, after early lettuce, radishes, turnips, etc. It may be used either in the green state for pickling, or dry for seasoning. A ready market for this vegetable in either form should be found among the foreign population of our mining towns.

POTATO, IRISH.

Space is reserved in the home garden for only the early crop of this vegetable, as a rule, since the main crop is generally grown in too large quantity to be included in its rather limited area. To obtain an extra early supply of tubers, a few seed potatoes may be sprouted. Select an early variety, such as Noroton Beauty, Early Ohio or Early Rose, and barely cover with moist sand in a shallow box, which should be placed under the glass of the frame, or in the house, where it is light and warm.. Supply moisture as needed and soon stocky, green shoots will appear and roots will be formed in the sand. As soon as the ground can be worked the potatoes may be taken from the sand and cut into pieces with one or more sprouts and planted. It will be well to cover the sprouts lightly with soil to protect them from the cold. If one is not anxious for such early results as may be obtained from the above method, the potatoes may be planted in the usual way as early as possible. An application in the furrow of a commercial fertilizer containing about ten per cent. of potash is desirable. If troubled with scabby potatoes, the seed should be treated before cutting, by soaking the tubers for two hours in a solution made by adding one-half pint of formalin to fifteen gallons of water. Potatoes may be kept in a cool, dark cellar, or may be buried in a pit or covered with soil in a pile out of doors.

POTATO, SWEET.

While the sweet potato succeeds best in the warm sandy loams of the southern states, it may be grown in the home gardens of this state, by bedding the same as described for the Irish potato, breakin goff the sprouts and planting in rich garden loam when it becomes thoroughly warmed. It may be best to make a furrow, mix manure or fertilizer evenly in this and then plant the potatoes in the middle of the ridge formed by turning two furrows together over the first. The potatoes should be dug as soon as the vines are killed by the frost, on a bright day, when they may dry quickly. Care should be taken not to bruise them. Sweet potatoes may be cured by placing the for a few days in a warm, well-ventilated room and then should be stored in a dry, cool place.

PUMPKIN.

This crop is usually grown for home use by planting a few hills in the corn field. It will pay, however, to grow in the home garden, some of the small sugar pumpkins. These are of better quality than the ordinary field sorts.

RADISH.

A rich mellow loam in which this crop may be grown rapidly will give crisp, tender radishes. A succession of sowings should be made beginning with the earliest one in the hot-bed and continuing throughout the season, ending with a late sowing in a hot-bed, started in the fall. As a rule radish seed is of a high germinating capacity, and it will save much necessary thinning if the seed is carefully sown.

RASPBERRIES.

The initial planting of the raspberry patch is made with the young plants or suckers which come from the roots of the older plants in the case of the red raspberry. The plants used in the case of the black raspberry are produced by the ends of the old canes taking root and forming new plants, called "tips." Either kind may be set in the fall or spring, although if set in the fall it is well to supply a mulch of strawy manure to prevent the heaving of the roots by the action of frost. The plants may be set three feet apart at first and the suckers or tips allowed to fill in the intervening spaces, forming a hedgerow, in which the plants should be kept thinned to about one foot apart. The old fruiting canes should be removed each spring. The black raspberry canes should be pinched back when they have reached a height of two feet, and the laterals are shortened to about a foot in the spring. The pinching of the shoots is usually omitted with the red raspberry, the canes being headed back in the spring and the laterals shortened the same as for the black raspberry. The bushes should not be allowed to bear the first season, and only lightly the season after planting.

RHUBARB.

A few hills will produce enough of this vegetable for home use and will afford a surplus to can, or to sell. Good roots with which to start the bed may be obtained from seedsmen for a moderate price, and can be divided in the spring or fall after they have grown a few seasons, to make additional hills. Like asparagus, there is little danger of getting the soil too rich for this crop. It is advisable to apply each fall a mulch of manure which should be worked into the soil in the spring. A supply of this vegetable may be had out of season by pursuing the following method: In the fall, just before freezing weather, dig up a few hills which have grown at least three years and allow the roots to become moderately frozen. Later in the winter, (about January first) remove to a cellar or other dark place which may be kept at a temperature of 55° to 60° F. Pack some good garden loam tightly around the roots and cover them lightly with the soil. Apply water when needed and the shoots will soon begin to appear. These may be gathered for some time, the product being of fine color and flavor. In the spring these roots may be replaced in the garden and allowed to recover from the forcing by not having any shoots removed for a season or two.

SALSIFY OR VEGETABLE OYSTER.

The culture of salsify is the same as that given the parsnip.

SPINACH.

This vegetable, which is so highly esteemed for use as greens, is of very simple culture. Several crops may be raised in a season, as it is ready for use in from thirty to sixty days from planting. It may be sown late in the fall and carried through the winter by protecting with straw. It may be grown as a companion crop between longer growing varieties. For example, as soon as the ground can be worked, two rows may be planted, one foot apart, between what will later be two rows of beans. The beans may be planted when it is warm enough, without disturbing the spinach, and the spinach will be mature and may be harvested before the beans are large enough to be injured by its presence. The spinach may also be planted before a later crop, or in the fall, after an early crop of some kind has been grown.

SQUASH.

A few hills of summer squash will furnish all that is required of this vegetable before the Boston Marrow takes its place in the early fall. The summer squash may be planted in hills four feet apart. The winter varieties should be given from six to eight feet each way. They are easily injured by frosts, so should be gathered before these occur. They should be cut from the vines and put into piles that may be covered readily, until the stems have thoroughly dried. Care should be taken not to break the stems or bruise the squash, as decay will soon take place under such circumstances. The squashes may be canned or they may be kept until well along toward spring by storing in a cool, dry place. They are excellent boiled or for use in pies.

STRAWBERRRIES.

The farmer's home garden is not complete without a strawberry bed large enough to give him a bountiful supply of this delicious fruit in its season, with a surplus to sell and to preserve for use in the winter months. Plants may be secured from a nurseryman or seedsman with which to start the bed, a few hundred being enough. A supply of plants for future needs may be grown at home, so that the initial expense is very slight. There are several systems of growing this fruit, but perhaps that best suited to the home garden is the narrow matted row. The plants are set in the spring, in rows about four feet apart and the plants about a foot and a half apart in the rows. As the summer advances, runners will be sent out from these plants. The cultivator should be run in the same direction each time. It will throw the runners in toward the original row, where they will take root, forming a bed of plants about one and a half feet wide. The plants should not be allowed to grow nearer than about six or eight inches apart. Those thinned out in the fall may be set closely in a bed and used to form a new bed in the spring. A light covering of straw should be placed over the plants after the ground freezes to prevent the tearing of the roots from the heaving caused by frost during the winter months. In the spring, if it is not put on too heavily, the plants will come up through the straw, which will keep the berries away from the ground and free from dirt. The season following the one in which the plants were set, the bed should produce a full crop. It will perhaps pay to fruit it another year ,but it is best to start a new bed each spring and discard the one which has borne two crops. Strawberry blossoms are either perfect or imperfect, according to the variety. That is, the imperfect blossom has pistils but no stamens. It is therefore necessary when planting those varieties having imperfect blossoms to put them between varieties having perfect blossoms in order that they may be fertilized and bear fruit. Seedsmen's catalogues generally describe this point for the different varieties.

TOMATOES.

For an early supply of tomatoes, the seed should be sown in February or March, in the hot-bed or cold frame. In about a month from planting the seedlings should be transplanted to about two inches apart. In about another month they should be transplanted again, either to four inch flower pots or into soiled berry baskets. As soon as it is warm enough they may be easily transplanted from these to the field without checking the plants. The tomato prefers a sandy or gravelly loam. Earliness of the fruit is hastened by training to one stem and tying to stakes. The plants may be set closer together when this is done, but for the main crop it will be best to set the plants on ridges made by plowing two furrows together. The green tomatoes which fail to ripen may be used for pickling, or those most advanced may be ripened by placing them under the glass of the frames.

TURNIPS.

The turnip may be grown as an early or as a late crop. For the first early, seed of Early White Milan may be sown as soon as the soil can be worked in the spring. Later, successive sowings may be made of White Egg. For the winter crop seed of White Egg or Am. Red Top may be sown in July or August. Turnips may be left in the ground until freezing weather, when they should be pulled, topped and covered with soil in piles in the field, or stored in a pit or cellar.

HELPFUL BOOKS ON GARDENING.

The following list of books, and their publishers, is given for the benefit of those who may wish to study the subject of gardening more in detail.

Principles of Vegetable Gardening—Bailey, Macmillan & Co., New York.

Bush Fruits—Card—Macmillan & Co., New York.

Vegetable Gardening—Green—Webb Pub. Co., St. Paul, Minn.

How to Make the Garden Pay—Greiner.

The following Farmers' Bulletins may be obtained free of charge by addressing the Secretary of Agriculture, U. S. Dept. of Agr., Washington, D. C.

No. 35. Potato Culture.
No. 61. Asparagus Culture.
No. 62. Marketing Farm Produce.
No. 77. The Liming of Soils.
No. 203. Canned Fruits, Preserves and Jellies .
No. 213. Raspberries.
No. 220. Tomatoes.
No. 254. Cucumbers.
No. 255. The Home Vegetable Garden.
No. 256. Preparation of Vegetables for the Table.
No. 266. Management of Soils to Conserve Moisture.
No. 282. Celery.
No. 289. Beans.
No. 324. Sweet Potatoes.

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 123. MAY 18, 1909

Diseases of Garden Crops and Their Control

By N. J. GIDDINGS

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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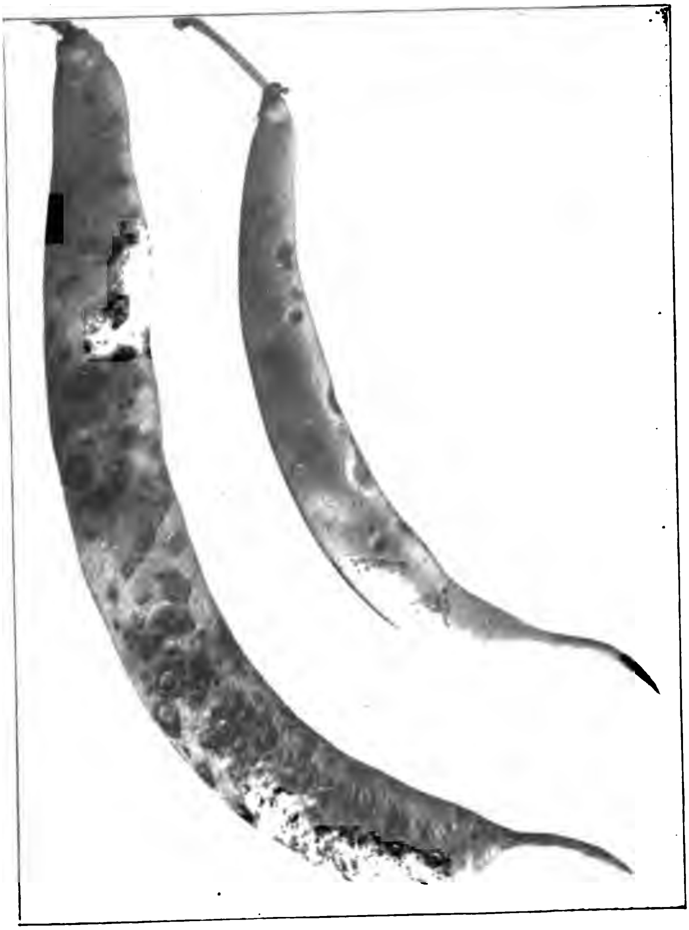
MAY 18, 1909.

This bulletin, concerning diseases of garden crops and their control, is the fourth of a series of practical bulletins to be issued by this Station from time to time for the promotion of the horticultural and trucking industries of the State. The first bulletin is upon the subject of certain enemies of cabbages and how to destroy them, the second upon apple enemies and how to fight them; and the third on the home garden.

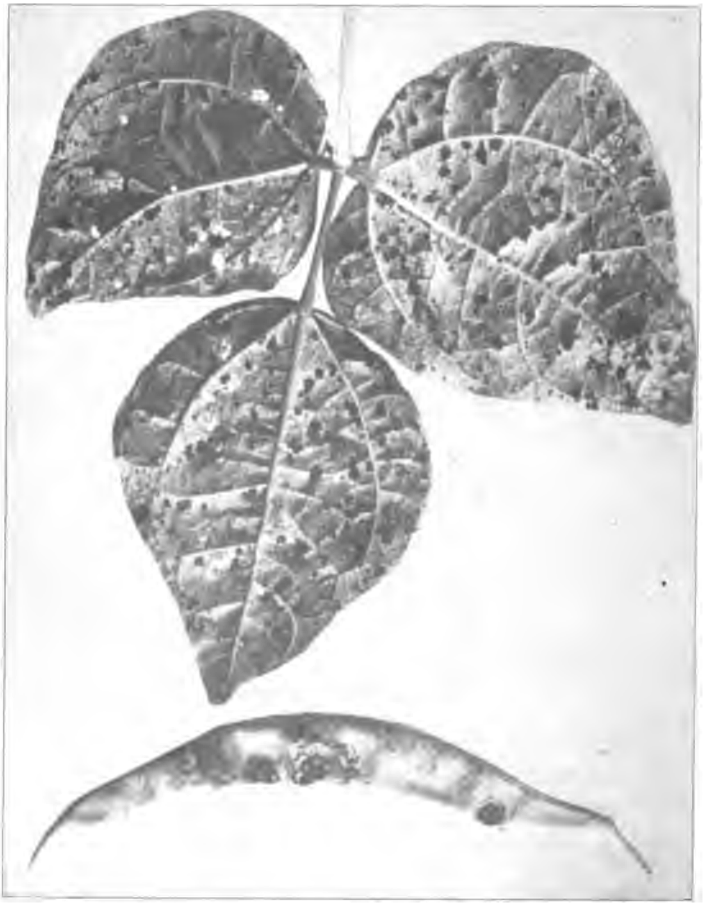
J. H. STEWART, *Director*.

PLATE I



Anthracnose of bean.

PLATE II.



Rust of bean.

Diseases of Garden Crops and Their Control

The diseases of garden crops are numerous and cause large financial losses in many fields every year. It is the aim of this bulletin to give brief general descriptions of some of the more common of these diseases so that they may be recognized, and to outline methods of treatment by which they may be controlled or prevented.

Since bordeaux mixture is the most important material which has yet been discovered for the prevention and control of plant diseases, a few words as to its preparation and use will be given at this time. It should be prepared as follows: Place 5 pounds of good unslaked lime in a barrel, add water slowly until it is all slaked, and then add enough more water to make 25 gallons in all. The mixture should be well stirred all the time while adding the water and must be allowed to cool before mixing with the copper sulphate.

Measure into another barrel 25 gallons of water and add to it 5 pounds of copper sulphate (bluestone). It is best to place the copper sulphate in a piece of coarse cloth such as sacking and let this hang in the barrel so that the sulphate is just below the surface of the water. It dissolves much quicker when suspended in this way than when allowed to lie at the bottom of the barrel. Each barrel should be fitted with a molasses gate about 1½ inches in diameter and should have a short trough leading from this gate to a small tub or box which in turn has a trough leading to the spray tank. The box or tub should be covered with a cheese cloth strainer to keep out lumps.

When the lime mixture has cooled stir it thoroughly and open the gate on both the lime barrel and the copper sulphate barrel. Regulate these gates to have about the same sized stream come from each, and so that both barrels are emptied at the same time. The materials come together on the strainer forming bordeaux mixture. It is necessary to keep stirring the materials on the strainer with one hand most of the time as the little lumps collect on the cloth and clog it. The lime mixture must be stirred almost constantly while it is running out because it settles very quickly.

If it is desired to use the spray against insect enemies as well as fungus diseases paris green may be added to the mixture at the rate of ½ pound to 50 gallons, or arsenate of lead at the rate of 3 pounds to 50 gallons. The insecticide should be mixed up in a little water before adding to the bordeaux so as to avoid lumps.

There are several other formulae for bordeaux mixture some calling for 4 pounds of lime and 4 pounds of copper sulphate, others for 6 pounds of lime and 4 pounds of copper sulphate to the 50 gallons of water. The amount of lime, however, is always equal to or greater than the amount of copper sulphate, and in any case the proper method of preparation is that described above. The practice of adding strong lime mixture to dilute copper sulphate solution usually gives good results, but the method here outlined is generally acknowledged as better.

Stock solutions are frequently used and save a considerable amount of time and trouble. The best way to make up these solutions is to use 1 pound of material to one gallon of water so that in the case of a stock solution of copper sulphate containing 30 pounds of the sulphate there would be 30 gallons of water. In the same way the lime after being slaked would have water added to it until it contained at the rate of 1 gallon of water to 1 pound of lime. For use 1 gallon of the stock solution would be diluted with 4 gallons of water, and the lime mixture must be thoroughly stirred each time before taking any from the barrel.

When bordeaux mixture is properly prepared, one can hardly apply too much. In case of doubt as to the amount to use on any crop it is well to apply as much as the leaves will carry without dripping.

There are various appliances for spraying plants, and one must be governed largely in his choice of machine by the amount of spraying to be done. For out-door work the barrel pump is probably the most useful and the most economical for the small grower. When one endeavors to apply bordeaux mixture to an out-door crop in a field of half an acre or more, using a knapsack sprayer, the amount used will seldom be sufficient for good results. The knapsack sprayers, bucket spray-pumps, etc., are designed more for green houses and small gardens or for the use of a strong insecticide solution. Large growers would of course do well to consider the purchase of a power sprayer. One of the greatest difficulties with the power sprayers now on the market is that they do not apply a sufficient amount of bordeaux.

(Other spraying formulae will be found at the end of this article.)

ASPARAGUS. [1]

Rust.—This disease may be recognized by the reddish or black pustules which occur on the stems and branches. It may be avoided to a large extent by planting on soil which is not too dry and by maintaining a high degree of fertility. At the end of the season all affected plants should be burned. No plants should be allowed to mature during the cutting season.

BEAN.

Anthracnose.—This disease attacks all parts of the bean plant, producing on the pods sunken scab like spots. It is carried over from one season to another in the seed. Hand sorting of the seed, picking out in this way any beans which show signs of the disease, is not recommended, but by selecting *pods* free from diseased spots and using seed from these, good results may be secured. In many cases large growers have found it profitable to spray with bordeaux mixture. All diseased plants should be collected and burned after harvesting the crop.

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[1] The descriptions and methods of treatment given here and on the following pages are those which the writer believes to be the best now known. Suggestions were secured from various sources and frequently from more than one concerning the same disease, so that no specific acknowledgements are considered necessary.

Rust.—The rust spots appear on the leaves, and occasionally on the pods, as brown powdery masses. The best method of controlling this trouble is to burn all diseased plants after harvesting the crop.

Blight—The blight is a bacterial disease producing large dead spots in the leaves and sometimes forming depressed watery spots on the pod. This disease is carried over in the seed, so that care should be taken to secure healthy seed. Spraying with the bordeaux mixture is said to reduce the injury.

BEET.

Leaf Spot.—The fungus causing this disease produces on the leaves numerous spots having a purple border and a gray center. It may be controlled by spraying with bordeaux mixture at intervals of about two weeks.

BLACKBERRY AND RASPBERRY.

Rust.—The rust is readily recognized by large orange colored spots on the leaves. These spots are usually on the under side. The fungus lives over from year to year in the canes so that all diseased plants should be taken out and burned.

Anthracnose.—This disease is frequently quite destructive. It produces small gray scab like spots on the canes. All diseased canes should be removed and burned. Spraying with bordeaux mixture will help to prevent it, but ordinarily this would not pay.

CABBAGE CAULIFLOWER AND TURNIP.

Club Root.—This disease is well known from the peculiar irregular enlargement of the roots. A field in which the

PLATE III.

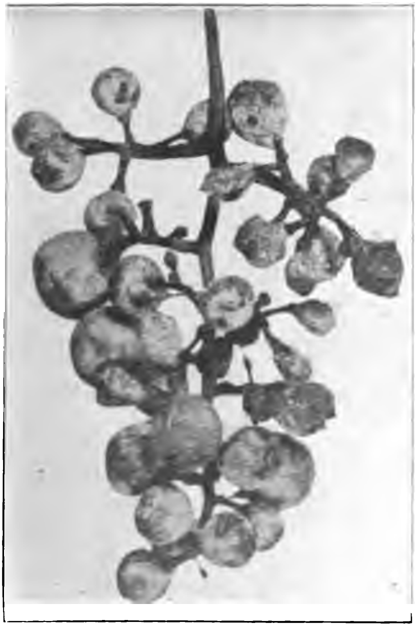

Fig. 1. Downy mildew of grape. After Freeman.

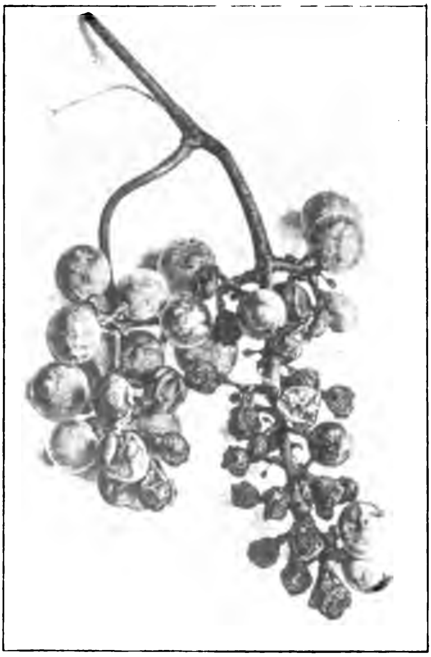

Fig. 2 Black rot of grape.

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disease has been present should not be planted to cabbages for several years, and should be kept free from kale, wild turnip, etc., as the fungus lives upon these plants. If it is impossible to avoid planting in an infected field, the ground should be limed at the rate of 50 to 75 bushels per acre. The seedlings should certainly be started in uninfected soil and if such cannot be secured in any other way, the soil may be well baked or steamed before using.

Black Rot.—This is a bacterial disease which is frequently carried on the seed. It is well to disinfect the seed by soaking them in formalin at the rate of 1 pint of formalin to 20 gallons of water, or in corrosive sublimate solution made up at the rate of 1 ounce of corrosive sublimate to 7 gallons of water. Seed should be soaked about 15 minutes.

CELERY.

Blight.—The blight appears on the celery plants as brown spots. When the disease appears early in the season, it may best be controlled by spraying with bordeaux mixture, but for the later sprayings, or in case it does not appear until late in the season, ammonical copper carbonate should be used as this will not stain the plants.

CORN.

Smut.—The large black swellings which this disease produces on corn stalks and ears are found in almost any corn field. The amount of damage done is seldom great but it may be lessened by destroying all diseased stalks and ears before they break open.

CRANBERRY.

Scald, Rot, or Red Rust.—This disease is most prominent and does its most serious damage on the berry. It produces small watery spots which rapidly spread until the whole berry becomes soft. On the leaves it produces irregular reddish brown spots. In controlling this it is important to destroy all diseased vines in order to prevent its spread. The regulation of water supply is also an important factor, and it is advised to keep the water at such a level that the surface of the bog will be continually moist but not wet. Spraying with bordeaux mixture has not been found very satisfactory.

CUCUMBER.

Anthracnose.—This appears as brownish spots on the leaves, and occasionally causes a rot of the young cucumbers. It may be largely controlled by spraying wih bordeaux mixture.

Mildew.—The fungus causing this disease produces angular yellowish spots on the leaves. In many sections of the country this is a very serious trouble and the station would be especially glad to receive specimens from anyone who suspects the disease in his field. It may be quite well controlled by spraying with bordeaux. The first spraying should be given when plants begin to run and it should be repeated about once in two weeks.

Wilt.—This is a bacterial disease causing the leaves of the plant to wilt and die. The best method of controlling this disease is to destroy or drive away all beetles, since they carry it from plant to plant. The bordeaux mixture is quite good to keep them off the vines.

CURRANT.

Leaf Spot.—There are several fungi which cause the spotting of currant leaves. This frequently results in a yellowing of the leaves and their premature death. In case the disease is quite severe, it might pay to spray with bordeaux mixture.

Cane Blight.—Plants attacked by this disease die suddenly. The bark is killed in places and the wood discolored. The best method of treatment is to take all diseased plants from the field and destroy them.

EGG PLANT.

Anthracnose.—This disease attacks the fruit, producing pits of various sizes. When serious, it may be controlled by spraying with bordeaux mixture, or with ammoniacal copper carbonate.

Leaf Spots.—This may be recognized by the brown spots which occur on the leaves. Spraying with bordeaux mixture is advisable for the control of this disease. Plants should not be grown on ground where the disease has occurred the previous year.

GOOSEBERRY.

Mildew.—A grayish white growth occurs on the fruit and leaves of diseased plants. This disease is very destructive upon some varieties. It may be largely controlled by setting the plants where there will be good circulation of air and cutting out the lower drooping branches. Spraying with potassium sulphide about once in 10 days from the time the buds open until the fruit is gathered is quite effective in controlling it.

GRAPE.

Black Rot.—This frequently causes quite severe losses in the grape crop. It produces small brown spots on the leaves, but is most serious upon the fruit, where it appears as small decayed spots which spread rapidly until the entire grape is discolored and shrunken. These shrunken or "mummied" grapes carry the disease over from one year to the next and care should be taken to carefully gather and destroy all such. Wet weather, or grass or weeds around the vines favors the development and spread of this disease, so that clean cultivation should be practiced if possible. Thorough spraying with bordeaux mixture will do much to prevent its development and spread. For late spraying, when the fruit begins to ripen, the ammoniacal copper carbonate is best, since it does not stain the fruit.

Anthracnose.—This disease produces brown spots on the leaves or stems, or, in case the fruit is attacked, scabs with bright colored borders. It may be readily controlled by thorough spraying with bordeaux mixture.

Downy Mildew.—Leaves attacked by this show first lighter green and then yellow spots above, while underneath there are white downy patches. It also attacks the fruits, covering them with a whitish growth and stopping their development. It may be controlled in the same manner as the black rot.

LETTUCE.

Drop or Rot.—This disease is more apt to occur in the greenhouse than out of doors and is not generally noticed until the plants suddenly wilt. It is easily controlled by steam sterilizing the soil to a depth of 2 or 3 inches a short time before planting. If it is not possible to do this, fresh soil should be used.

MUSKMELON.

Anthracnose.—This attacks both leaves and fruit, producing black spots which may show smaller pink spots or patches. It has been reported as quite destructive in some parts of this state. Spraying with bordeaux mixture has been found quite effective in controlling it.

Downy Mildew or Blight.—This is a serious disease in many places, and may be recognized by the angular, brown, dead spots which are produced on the leaves. When badly spotted, the leaves dry up and die. The fruit from such vines is said to be of inferior quality, and frequently fails to ripen. The fungus causing this disease is the same one which causes the downy mildew of the cucumber. The bordeaux mixture has been found less effective in controlling this disease on muskmelons than on cucumbers. When the disease has appeared in a field, planting in new soil is sometimes advised.

Wilt.—This is a bacterial disease caused by the same

PLATE IV.

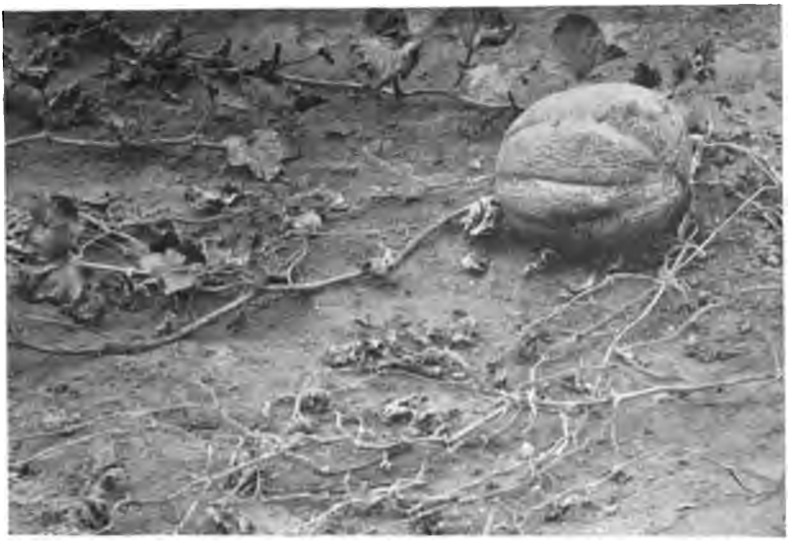

Fig. 1. Muskmelon vine destroyed by blight. After Clinton.

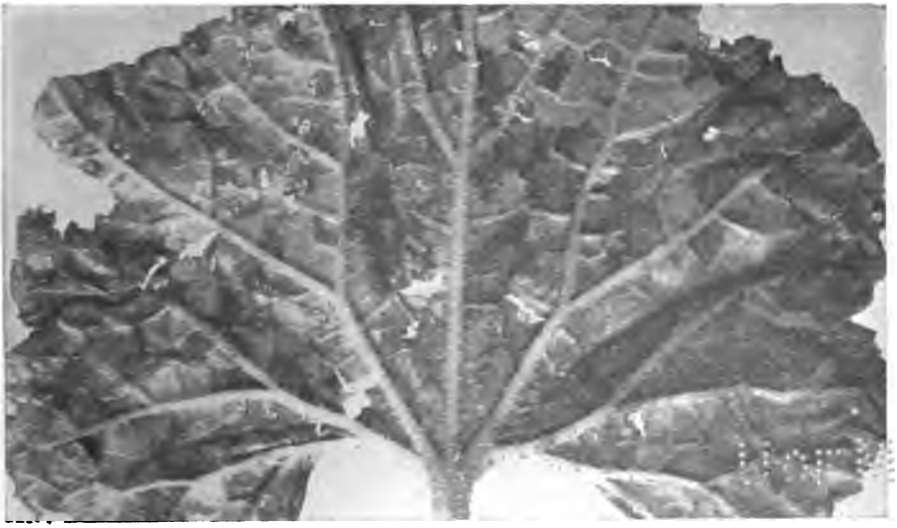

Fig. 2. Under surface of blighted muskmelon leaf, showing dead spots. After Clinton.

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organism as the cucumber wilt. It seldom does any great amount of injury, and the best methods of control are to keep the vines free from beetles, dstroy all diseased plants, and plant on new soil the next year.

ONION.

Mildew, or Blight.—The fungus causing this disease produces gray spots on the leaves, and these enlarge until the entire leaf may be covered. It is sometimes quite destructive, especially upon young plants. After the disease has appeared in a field, onions should not be grown there for at least two years. Bordeaux mixture is quite effective in controlling this disease, but it must contain some adhesive (see formulae at close of article) to make it stick to the leaves.

Smut.—This may be recognized by the small black pustules which appear on the leaves, or sometimes on the bulbs. It is most often destructive on young seedlings. Formalin, diluted at the rate of 1 pint to 30 gallons of water, and applied to the seed just before covering, by means of a drip attachment on the seeder, has been found quite valuable in preventing this disease. One gallon of this solution is sufficient for about 400 feet of drill. A mixture of 50 pounds of lime and 100 pounds of sulphur applied in the drills is also a good preventive. This mixture should be applied at the rate of 150 pounds per acre.

PEA.

Mildew.—This produces a white coating on both sides of the leaves, and such leaves soon become yellow and die. It may be largely controlled by spraying with bordeaux mixture, but the amount of damage is not ordinarily great enough to warrant going to much expense for spraying.

Anthracnose.—This appears as small reddish spots on the leaves, pods, or stalks. It frequently causes a considerable amount of loss. Spraying with bordeaux mixture will generally help to prevent the disease.

POTATO.

Early Blight.—This is a very common and destructive disease, making its appearance during July. It produces brown spots on the leaves. These spots usually show well marked concentric circles. A poisoning due to strong insecticides sometimes causes a similar marking of the leaf, but, in such cases, the center of the spot is always an injury of some kind, frequently a flea-beetle puncture. The early blight spots are often so numerous that they unite causing the entire leaf to die. Bordeaux mixture has been found quite effective in controlling this disease.

Late Blight.—The late blight of the potato is sometimes though rarely found on the vine in July. It generally makes its appearance in August and does its greatest damage during the latter part of that month and early September. It, like the early blight, attacks the leaves at any point, but produces, instead of the concentric circles, an area which at first looks as though it had been injured with hot water. This scalded area later becomes yellow and dead. Near the edges of these spots on the under surface of the leaf there is a fine white growth. The same fungus which causes the death of the leaves causes a decay of the potatoes, so that fields which have been infected with the disease should have the potato tops kept from contact with the potatoes at the time of digging. Thorough spraying with bordeaux mixture is a reliable remedy for the disease.

Scab—The scab spots produced on potatoes are too well known to require a description. The fungus causing this disease lives over from year to year in the soil, and is also carried over on tubers having scab spots. The only practical remedy is to use clean seed disinfected with formalin, used at the rate of 1 pint to 30 gallons of water, or with corrosive sublimate used at the rate of 4 ounces to 30 gallons of water, and then to plant on clean soil. Land which has grown scabby potatoes should not be again used for growing potatoes for at least three years. There is no method of treatment known by which clean potatoes can be grown in soil infested with the scab. The fungus which causes the disease thrives best in a soil containing lime or ashes so that applications of these materials to soil where potatoes are to be grown should be avoided.

Fusarium Wilt.—This is a disease attacking the stems of the potato plant, causing them to wilt and die. The same fungus causes a dry rot of the tubers. The best methods of control for this disease are to avoid planting any diseased tubers, and to plant on fresh soil.

Bacterial Wilt.—This is a bacterial disease which causes the plant to wilt and die. A soft rot of the potatoes is caused by the same bacteria. It may be prevented by avoiding any seed tubers which show signs of the soft rot, destroying or driving away all beetles, and planting on soil which did not have a crop containing diseased plants the year before.

Leaf Blotch.—This may be recognized by the small slate colored spots which appear on the under side of the leaves during July and August. It has not been known to cause serious injury to a crop, and definite methods of control are not given.

RASPBERRY.

(See under Blackberry).

SQUASH.

The squash is subject to the same diseases as the cucumber, and their methods of control are the same.

STRAWBERRY.

Leaf Spot or Blight.—This appears on the leaves as white spots which have a purple border. The fungus passes the winter in dead leaves, so that all such should be removed from the field and destroyed. Spraying with bordeaux mixture is also quite effective against it.

TOMATO.

Rust or Leaf Spot.—Tomato leaves affected with this show numerous small brown spots. The disease sometimes causes quite serious loss in the production of tomatoes, since affected leaves finally dry up and die, and the fruit from such vines is of inferior quality and size. The bordeaux mixture spray is the best known preventive for this disease.

Bacterial Blight or Wilt.—This is similar to the bacterial wilt of the Potato and the best methods of treatment are the destruction of biting insects, and growing plants on soil where the disease has not been present for 2 or 3 years.

Fungus Blight.—This disease causes the leaves to die beginning with the lower ones and continuing upward along the stock. The stem when cut across shows darkened veins. The fungus which causes the disease lives over in the soil from year to year, so that the best method of treatment is to keep infested soil free from tomatoes for at least 3 years after a crop showing the disease has been there.

TURNIP.

The diseases of turnip are practically the same as those of the cabbage and cauliflower, and the methods of treatment are similar. (See under cabbage).

WATERMELON

Anthracnose.—This may be recognized by the black spots which appear on the vines and fruits. The older spots may show small pink areas in them. The disease has been reported

PLATE V

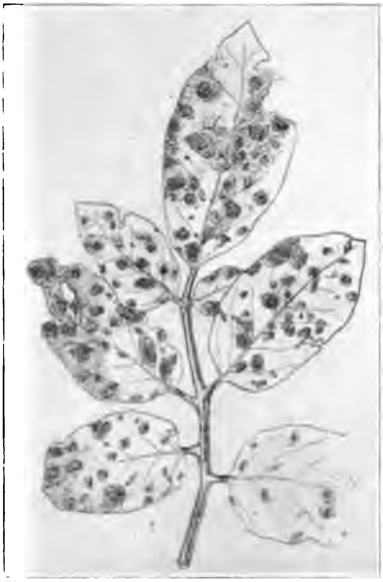

Fig. 1. Sketch of potato leaf, showing spots produced by early blight fungus. After Jones.

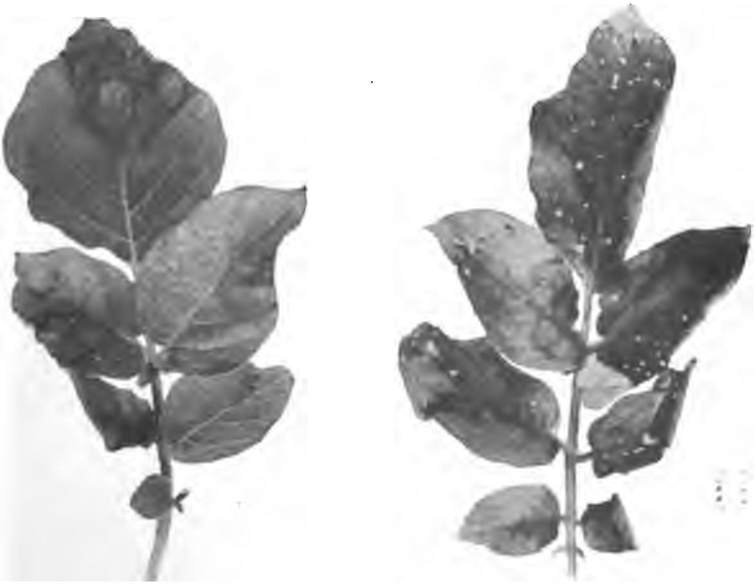

Fig. 2. Photograph of potato leaves diseased with late blight. After Clinton.

as very destructive in some portions of this state. Spraying the vines with bordeaux mixture was found to greatly reduce the amount of injury.

Leaf Spot.—This disease may be distinguished from the anthracnose by the gray center in the spots. It does not attack the fruits. Thorough spraying with bordeaux mixture is recommended for its control.

FORMULAE

BORDEAUX MIXTURE

Copper sulphate	5 lbs.
Stone lime	5 lbs.
Water	50 gal.

For detailed instructions see front part of bulletin.

AMMONIACAL COPPER CARBONATE.

Copper carbonate	5 oz.
Ammonia	3 pints
Water	50 gal.

Dilute the ammonia in 7 or 8 parts of water. Make a paste of the copper carbonate with a little water. Add the paste to the diluted ammonia and stir until dissolved. Add enough water to make 50 gallons. The mixture should be made up fresh for it loses its strength on standing.

CORROSIVE SUBLIMATE

Corrosive sublimate	4 oz.
Water	30 gal.

It is best to dissolve the corrosive sublimate in 2 to 3 gallons of hot water and add this solution while hot to the remainder of the water. This amount is sufficient to disinfect 25 to 30 bushels of potatoes for scab. Metal dishes must not be used for containing any corrosive sublimate solution.

FORMALIN.

Formalin	1 pt.
Water	30 gal.

This amount is sufficient for disinfecting about 20 bushels of potatoes for scab.

ADHESIVE MIXTURE

Sal soda	1 lb.
Resin	2 lbs.
Water	1 gal.

Boil 1 to 1½ hours in an iron kettle. Add this amount to 50 gallons of bordeaux mixture for spraying onions, cabbage or other plants from which the regular bordeaux runs off too readily.

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 124 AUGUST, 1909

Some Factors Influencing the Vigor of Incubator Chickens

1. Age and Vigor of Parent Stock
2. Cooling Eggs During Incubation
3. The Use of Moisture

J. H. STEWART AND HORACE ATWOOD

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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A Few Preliminary Experiments on the Effect of the Age of the Parents Upon the Vigor of Chickens.

Early hatched pullets lay better in winter, when eggs are high in price, than old hens, and as a consequence on many egg farms practically all of the older hens are disposed of each summer and their place is taken by pullets hatched during the preceding spring. While this undoubtedly is good policy from the standpoint of winter egg production, yet it has led in many cases into the practice of incubating the eggs of these pullets, during the following spring, when the fowls are practically one year old. Is it a good plan to use such eggs for hatching? Are the resulting chicks strong and hearty, and do they develop into as thrifty, vigorous individuals as though they were the offspring of more mature stock? The experiments described below have been performed to throw light on this question.

TEST 1.

In this experiment three pens of single comb White Leghorns were used. Pen 1 consisted of pullets; pen 2 consisted of hens two years old; and pen 3 consisted of hens three years old. They were of the same strain, and were fed and handled in the same manner. The cocks which were mated with them were alternately placed in the different pens so as to eliminate any possible effect resulting from the individuality of the males. The three year old hens had been selected with particular reference to size and apparent vigor.

The following table shows the number of eggs incubated from each lot of fowls, the weight of the eggs, the weight of the chickens when removed from the incubator, and other details of the test. The eggs were hatched in one incubator and the chicks kept separate at hatching time by means of "pedigree trays."

Cyphers incubator, started June 3, 1907.

	Pen 1.	Pen 2	Pen 3.
Number of eggs put in incubator	55	79	74
Weight of eggs per hundred....	11.50 lbs.	12.18 lbs.	14.29 lbs.
Tested out as unfertile........	8	9	5
Unhatched	2	10	9
Number of chickens..........	45	60	60
Per cent hatched of all eggs incubated	81.8	75.9	81.1
Weight of chickens per hundred when revomed from incubator	7.33 lbs.	7.54 lbs.	8.47 lbs.

The eggs from the hens three years old were heavier, and the chickens were heavier than in the case of the younger fowls.

The chickens were placed in "Universal Hovers" and fed and treated as nearly alike as possible. An accident caused this experiment to terminate July 6th. Up to that time there had died 21 chickens hatched from eggs laid by pullets, 8 chickens from eggs laid by hens two years old, and 6 chickens hatched from eggs laid by hens three years old. Most of these deaths seemed to be due to digestive troubles.

In this test, then, the eggs laid by hens three years old were more satisfactory for hatching than those laid by the younger fowls for the chicks were heavier, and much more vigorous than the chickens hatched from pullet eggs, and apparently somewhat more vigorous than the chicks hatched from eggs laid by hens two years old. There was not much difference in the hatchability of the eggs.

The following table shows the details of the second test.

TEST 2.

Cyphers Incubator, started June 19, 1907.

	Pen 1.	Pen 2.	Pen 3.
Number of eggs put in incubator	114	92	88
Weight of eggs per hundred	11.71 lbs.	12.22 lbs.	13.16 lbs.
Tested out July 4th as infertile	19	15	9
Cracked in turning and removed	none	4	5
Number of chickens	76	62	64
Percentage hatched of all eggs incubated except those cracked	66.7	70.5	77.1
Weight of chickens per hundred when removed from incubator	7.64 lbs.	7.75 lbs.	8.50 lbs.
Number of deaths during first two weeks	12	7	3
Weight of chickens when forty days old, per hundred	24.7 lbs.	27.6 lbs.	35.0 lbs.

In this test the oldest hens laid eggs that hatched out more, heavier and stronger chickens than in the case of the younger hens. The growth of the chickens was slow, due partly at least to the heat of summer, but the chickens from the three year old hens were materially heavier than the others when forty days old.

TEST 3.

Eggs incubated in Prairie State Incubator, started Sept. 5, 1907.

	Pen 1.	Pen 2.	Pen 3.
Number of eggs put in incubator	71	55	57
Weight of eggs per hundred	12.21 lbs.	12.04 lbs.	13.07 lbs
Tested out unfertile Sept. 17th	18	7	8
Number of chickens	51	46	39
Percentage hatched of all eggs incubated	71.8	83.6	68.4
Weight of chickens when removed from incubator, per hundred	7.64 lbs.	7.71 lbs.	8.0 lbs.
Number of deaths during first four weeks	5	1	3

The chickens were brooded in "Universal Hovers" in adjoining colony houses, and through an oversight they became mixed together when four weeks of age, making it impossibe to obtain the weight of each lot of chickens and the experiment was discontinued.

In this test also the eggs laid by the oldest hens were largest and hatched out the heaviest chickens. The best hatch was obtained from the eggs laid by the two year old hens. The death losses were low with a possible exception in the case of the chicks hatched from eggs laid by the youngest fowls, but with this lot of chickens the five deaths recorded may have been due to the chickens catching cold, as four or five chickens in this lot were found by the attendant huddled together one morning outside the brooder, where they probably had remained for sometime in the cold.

TEST 4.

This test was begun April 20, 1908, and a Cyphers Incubator was used for hatching the eggs. Eggs from three lots of Single Comb White Leghorn fowls of the same strain were employed. Lot 1 consisted of pullets and cockerels hatched October 14, 1907, making these fowls practically six months old when the eggs were laid that were used in this test. Lots 2 and 3 consisted of three year old fowls of superior size and vigor. Lot 2 had been kept in a fresh air house during the winter of 1907-8, and they had not been fed for egg production, while lot 3, on the other hand, had been wintered in a warmer house and had been fed heavily for the production of eggs.

The following table shows the details of the test.

	Pen 1.	Pen 2.	Pen 3.
Number of eggs incubated......	104	72	72
Weight of eggs per hundred....	9.95 lbs.	13.5 lbs.	13.3 lbs.
Tested out May 4th as unfertile..	28	8	36
Cracked in turning............	1	3	2
Number of chickens............	69	86	
Per cent hatched of all eggs incubated except those cracked....	66.99	61.87	
Weight of chickens per hundred when removed from incubator.	6.46 lbs.	9.17 lbs.	
Weight of chicks per hundred when forty-six days old......	30.74 lbs.	37.32 lbs.	
Number of chickens died in first forty-six days	10	2	

In this test also the older fowls laid eggs that were larger and which hatched out larger and stronger chicks than was the case with the younger, less mature fowls. The heavy feeding for egg production which pen three received during the winter apparently affected the fertility of the eggs, as there were more than four times as many unfertile eggs from this lot of fowls as from the other lot of three year old hens that had not been forced for egg production during the winter.

TEST 5.

This test was begun March 23, 1909. The eggs were hatched in a Model incubator equipped with a moisture regulator. Eggs from two lots of White Leghorn fowls were employed. Lot 1 consisted of hens three years old that had been kept during the winter in an open shed and fed entirely upon whole grain. On account of their age, method of feeding, and their cold quarters there was practically no egg production from these fowls from the beginning of moult until the latter part of February. The fowls in this flock numbered about one hundred, and they had been selected from a larger flock on account of their size, and apparently vigorous constitutions. During the winter preceding this test they were perfectly healthy, no colds, roup, or other disturbance having been noticed. With this flock of hens there had been placed earlier in the season five cockerels and one cock three years old. The fowls were allowed free range. The second lot of fowls were practically six months old at the beginning of the experiment and they were mated with cockerels of the same age.

The following table gives the details of the test.

	Old Hens.	Pullets
Number of eggs incubated	110	110
Weight of eggs per hundred	13.09 lbs.	10.09 lbs.
Tested out tenth day	8	20
Dead in shell at end of hatch	8	15
Number of chicks	94	75
Weight of chicks per hundred when removed from incubator	8.24 lbs.	6.51 lbs.
Weight per hundred when 22 days old	25.17 lbs.	18.31 lbs.
Deaths from all causes during first 22 days	1	6

In this test the old hens laid eggs which were larger and hatched better, and the chicks were larger, stronger and grew faster than was the case with the chicks hatched from eggs laid by the younger fowls.

TEST 6.

This test was begun April 5, 1909. Eggs were used from the same fowls as in the preceding test. The eggs from both lots of fowls were hatched in a 360 Egg Cyphers Incubator.

The following table gives the details of this test.

	Old Hens.	Pullets
Number of eggs incubated	180	180
Weight of eggs per hundred	13.04 lbs.	10.30 lbs.
Cracked in turning	2	1
Tested out April 15th	12	22
Dead in shell at end of hatch	14	30
Number of chicks	152	127
Weight of chicks per hundred when removed from incubator	9.15 lbs.	6.75 lbs.
Deaths from all causes during first three weeks	3	14
Weight of chicks per hundred three weeks old	25.4 lbs.	19.0 lbs.

In all essential features this test is in accord with the preceding one, as the chicks from the old hens were larger and stronger than the others.

TEST 7.

In this test eggs were incubated from the three year old hens already mentioned and from pullets hatched early in the spring of 1908. During the winter of 1908-9 these pullets had been fed liberally for egg production and at the beginning of the test they had been laying heavily for six months.

The following table gives the details of this test, which was begun April 14, 1909.

Incubator used—Cornell. 120-egg size.

	Old Hens.	Young Fowls.
Number of eggs incubated	60	60
Weight of eggs per hundred	13.2 lbs.	11.7 lbs.
Tested out April 30th	9	23
Total number of chicks	39	25
Weight of chicks per hundred when removed from incubator	8.33 lbs.	7.00 lbs.
Total died in 26 days	2	5
Weight of chicks per hundred when 26 days old	26.9 lbs.	22.6 lbs.

In this test also the chicks hatched from eggs laid by old hens hatched better and they were larger, stronger and grew faster than the chicks hatched from eggs laid by the younger fowls.

TEST 8.

In this test eggs were incubated from the same hens as in the preceding test.

The following table gives the details of this experiment which was begun May 22, 1909.

Incubator used—Cyphers, 360-egg size.

	Old Fowls.	Young Fowls.
Number of eggs incubated	180	180
Weight of eggs per hundred	12.5 lbs.	12.1 lbs.
Cracked in turning	9	1
Unfertile	19	48
Dead in shell at end of hatch	14	8
Number of chicks	138	123
Weight of chicks when removed from incubator per hundred	8.24 lbs.	7.68 lbs.
Total deaths in 21 days	6	12

The chicks in this test were brooded in a Cornell University gasoline brooder, and they were allowed free range. When they were weighed on the 21st day it was found that a considerable number of them were missing, having been killed by cats or rats, consequently the comparative weights of the two lots of chicks could not be determined. The figures showing the "total deaths" represent the number of chicks that died in the brooder, and probably represents quite accurately the comparative vigor of the two lots of chickens.

SUMMARY.

The following table summarizes the results of the eight experiments.

	Old Hens.	Pullets.
Total number of eggs incubated less those cracked in turning..........	1094	871
Average weight of eggs per hundred......	12.96 lbs.	11.19 lbs.
Total number of chicks..................	840	591
Per cent hatched of eggs incubated......	76.7	67.8
Average weight of chicks per hundred when removed from incubator........	8.28 lbs.	7.12 lbs.
Average weight of chicks at second weighing, per hundred................	29.56 lbs.	23.07 lbs.
Total number of recorded deaths.........	42	85
Per cent of chicks which died..........	5	14.5

The results of this series of experiments clearly show that it is a matter of prime importance to have the breeding stock vigorous and of mature age. The eggs from the young fowls were smaller than the eggs from the older hens, and the chicks were smaller when they were hatched, grew more slowly, and more of them died from chick diseases than was the case with chicks hatched from eggs laid by the mature fowls.

AIRING AND COOLING EGGS DURING INCUBATION.

Eggs hatched under natural conditions are left unprotected when the broody hen leaves the nest in search of food. At such times the eggs become cool or even cold, and being freely exposed to the air the absorption of oxygen and the excretion of carbon dioxide is facilitated. In the popular mind this process of cooling and airing is associated with the development of strong vigorous chicks, and consequently it is not surprising to find many incubator manufacturers giving directions in regard to cooling and airing eggs during the process of incubation. There is, however, a general lack of specific instructions or advice as to how long to cool the eggs or how cold to allow them to become.

In the case of natural incubation it would seem that the process of cooling and airing is due to the necessity of the mother hen of obtaining food, and may have no connection whatever with normal incubation. Instead of being of benefit the cooling of eggs during incubation may be detrimental in as much as cooling the eggs tends to slow down the vital processes and delays the development of the embryos.

In the case of machines in which the ventilation is imperfect it is quite possible that the cooling and airing process may be of benefit by giving the embryos fresh air rather than through the cooling effect, although it must be admitted that merely the cooling of the eggs may be the means of giving the embryos an increased supply of oxygen, for, when an egg is cooled the heated air in the air cell contracts and a small amount of air is drawn in through the pores of the shell.

The experiments described below have been carried out in order to determine if possible whether eggs should be cooled and aired during incubation, and if so the reason or reasons for the beneficial effects observed.

The tests were carried out in a well lighted and well ventilated incubator room, the lower four feet of which are below the level of the ground. The side walls to that height are of cement, and above the cement walls are windows which are kept open thus allowing the wind to blow directly across the room. The temperature prevailing during the hatches was recorded by maximum and minimum thermometers located a short distance from the incubator room, and while the temperature of the room would scarcely fluctuate so widely as the temperature outside, yet these temperatures are suitable for making a comparison of the conditions prevailing when the different hatches were made.

TEST 1.

This experiment was begun August 17, 1908. Two 360 egg Cyphers incubators were used in which to hatch the eggs and the chicks were brooded in two Cornell University gasoline brooders. White Leghorn eggs from a large flock were used and they were carefully selected so as to make the eggs in the two incubators as similar as possible. The two incubators were operated as is customary, the eggs being turned by hand twice each day and removed from the incubator chamber at each turning. The regulators were so adjusted as to hold the temperature at 102 1-2 degrees during the first half of the hatch and at 103 degrees during the latter half. The ventilators were kept open during the entire hatch.

Beginning on the second day of incubation and continuing until the nineteenth day the trays of eggs of one of the machines were removed from the incubator and covered with a thick woolen cloth and cooled as is shown in the following table. The temperature of the eggs was taken by a thermometer resting upon the eggs and covered by the blanket.

AIRING EGGS IN MACHINE NO. 1.

Eggs left out of the machine in the morning and covered with a woolen blanket for times specified.

		Temperature of the air			When began	When put	Minutes	Cooled
		Maximum.	Minimum.	At 6 P. M.	to air.	back.	aired,	to
Aug.	19.	85	55	81	6:40	7:40	60	80
	20.	82	53	67	6:30	8:30	120	82
	21.	84	49	73	6:20	8:45	145	84
	22.	78	65	74	6:35	9:00	145	85
	23.	78	58	71	6:50	9:00	130	83
	24.	77	48	70	6:15	8:15	120	82
	25.	72	59	80	6:15	8:15	120	82
	26.	70	55	59	6:20	8:15	115	82
	27.	..	..	..	6:30	9:00	150	84
	28.	74	50	67	6:30	9:10	160	83
	29.	80	56	66	6:10	9:30	200	88
	30.	83	52	68	6:45	9:30	165	88
	31.	88	53	74	6:15	9:40	205	92
Sept.	1.	90	58	85	6:00	9:00	180	88
	2.	86	63	71	6:00	8:45	165	89
	3.	74	44	69	6:00	9:15	195	86
	4.	83	49	75	6:20	9:45	205	85
	5.	76,	63	68	6:20	8:55	165	88
Average		80	54.7	71.6			152.5	85

Although both machines were operated at the same temperature the cooled eggs hatched about twenty-four hours later than the others or practically on the twenty-second day.

The following table gives the details of the hatch.

	Cyphers Incubator. Eggs cooled.	Cyphers Incubator. Eggs not cooled.
Number of eggs incubated	360	360
Weight of eggs per hundred	12.3 lbs.	12.3 lbs.
Loss in weight in 9 days	3.25 lbs.	3.45 lbs.
Eggs cracked in turning	5	2
Tested out on the tenth day.		
Dead germs	19	22
Unfertile	41	42
Dead in shell at end of hatch	57	39
Number of chicks	238	255
Per cent hatched of all eggs incubated except those cracked	67%	71.2%
Weight of chicks per hundred when removed from incubator	8.17 lbs.	8.13 lbs.

When removed from the incubator the chickens were marked and one-half of them from each machine were placed in each of two gasoline brooders. The chickens from both incubators being mixed together were subjected to the same conditions as to food and temperature. The brooding experiment was terminated September 28th, or when the chickens were three weeks old. Up to that time there had died sixteen chickens from the lot hatched from eggs that were not cooled, and eighteen chickens from the cooled eggs. Most of these deaths seemed to be due to digestive troubles, or non-absorption of the yolk sack.

When three weeks old the chickens from the cooled eggs weighed 14.7 pounds per hundred chickens, while the chicks from eggs not cooled weighed 16.8 pounds per hundred.

Result of test.—In this experiment a better hatch was obtained from the eggs not cooled, and slightly less of the chickens from the eggs not cooled died during the first three weeks, and they averaged somewhat heavier at the expiration of that time than the chicks from the cooled eggs.

TEST 2.

This test was begun March 12, 1909. A three-hundred and sixty egg size Cyphers incubator was used having two trays. One tray was cooled as shown below, while the other tray was cooled no longer than was necessary when it was removed from the incubator for turning the eggs.

The incubator was operated in the usual manner, the eggs being turned twice per day. The hatching of the cooled eggs was delayed by the cooling about twenty-four hours. The eggs not cooled hatched promptly on time. When the eggs began to pip one tray was removed to another incubator so as to keep the chicks from the two trays apart so that they could be marked. After the chicks were marked they were placed together in a Cornell University gasoline brooder. The following table shows the details of the hatch.

Cyphers incubator started March 12, 1909. One tray cooled and aired. The other not cooled. Ventilators were closed until beginning of hatch then they were left open. The lower felt diaphragm was not used.

	Tray No. 1. Cooled.	Tray No. 2. Not cooled.
Put in incubator..................	180 eggs.	180 eggs.
Weight of eggs per hundred........	12.9 lbs.	12.9 lbs.
Loss in weight in 19 days..........	3.22 lbs.	3.30 lbs.
Normal loss as calculated..........	3.68	3.68
Eggs cracked in turning............	5	1
Unfertile eggs	20	18
Dead in shell......................	26	16
Number of chickens................	129	145
Weight of chicks per hundred when removed from incubator....	8.33 lbs.	7.85 lbs.
Weight of chicks 3 weeks old......	23.81 lbs.	25.9 lbs.
Total deaths during first 3 weeks....	13	2

Cooling was begun on the fourth day of the hatch. The tray of eggs was removed from the incubator and covered while outside the incubator with a thick woolen cloth so as to make the change of temperature gradual. A thermometer was laid on the eggs and covered by the cloth. The reading of the thermometer at the close of each cooling period is shown in the last column of the following table:

		Temperature of the air.			Minutes cooled.	Temperature of eggs at end.
		Maximum.	Minimum,	At 6 P. M.		
March	16.	40	28	31	15	86°
	17.	32	20	28	15	85°
	18.	44	18	43	31	80°
	19.	55	36	54	55	75°
	20.	54	34	39	55	75°
	21.	50	27	28	60	75°
	22.	51	26	37	45	78°
	23.	45	19	40	20	75°
	24.	56	29	54	60	75°
	25.	54	29	29	65	75°
	26.	47	27	46	55	75°
	27.	57	38	56	45	78°
	28.	50	32	42	30	78°
	29.	50	32	47	60	80°
	30.	47	30	38	60	75°
	31.	39	29	38	80	75°
Average		48+	28+	40+	47	77+°

Result of the test. The eggs not cooled hatched better and the chickens were healthier and grew faster than the chickens from the cooled eggs.

TEST 3.

This test was begun May 23, 1909. A 360-egg size Cyphers incubator was used, and the experiment was carried on in the same way as the preceding one. Cooling was begun on the fourth day and was continued as shown in the following table. The eggs were not covered while cooling.

		Temperature of the air.			Minutes cooled.	Temperature of eggs at end.
		Maximum.	Minimum,	At 6 P. M.		
May	27.	78	60	65	16	88°
	28.	69	58	66	24	90°
	29.	77	56	75	18	88°
	30.	80	48	65	13	90°
	31.	83	58	79	20	92°
June	1.	82	62	67	20	92°
	2.	80	58	71	17	90°
	3.	75	62	73	20	90°
	4.	79	65	73	17	92°
	5.	73	60	70	20	92°
	6.	78	60	75	28	90°
	7.	81	56	78	25	92°
	8.	79	63	63	20	94°
	9.	77	60	73	15	96°
	10.	76	65	71	16	94°
	11.	75	68	70	16	94°
	12.	79	53	71	15	94°
Average		77+	59+	71—	19—	91+

The following table shows the details of the experiment. The bottom ventilators remained closed until the beginning of the hatch. Then they were opened.

	Eggs cooled.	Eggs not cooled.
Number of eggs incubated	180	180
Weight of 180 eggs	21.32 lbs.	21.47 lbs.
Cracked in turning	2	4
Weight of eggs June 6th	19.05 lbs.	19.25 lbs.
Unfertile	27	25
Dead in shell at end of hatch	17	14
Number of chicks	134	137
Weight of chicks per hundred when removed from incubator	7.87 lbs.	7.94 lbs.
Weight of chicks per hundred when 16 days old	13.0 lbs.	12.4 lbs.
Total deaths during first 16 days	4	13

TEST 4.

This experiment was begun May 25, 1909. A Cyphers incubator was employed, and the eggs were cooled and the work carried on similar to the preceding test.

The following table gives the details of the hatch.

	Eggs cooled.	Eggs not cooled.
Number of eggs incubated	180	180
Weight of 180 eggs	22.12 lbs.	22.08 lbs.
Cracked in turning	3	5
Weight of eggs June 6th	20.12 lbs.	20.25 lbs.
Unfertile	42	34
Dead in shell at end of hatch	19	13
Number of chicks	116	128
Weight of chicks per hundred when removed from incubator	8.18 lbs.	8.02 lbs.
Weight per hundred when 14 days old	13.3 lbs.	13.4 lbs.
Total deaths during first 14 days	1	9

TEST 5.

This test was begun May 25, 1909, and was carried on in the same way as the two preceding tests. A 1908-model Prairie State Incubator was used. The side ventilator remained closed during the hatch. The table below shows the details of the test.

	Eggs cooled.	Eggs not cooled.
Number of eggs incubated	180	180
Weight of 180 eggs	22.12 lbs.	22.12 lbs.
Weight of eggs June 6th	20.77 lbs.	20.86 lbs.
Cracked in turning	3	none
Unfertile	22	38
Dead in shell	12	18
Number of chicks	143	124
Weight of chicks per hundred when removed from incubator	8.08 lbs.	8.47 lbs.
Weight of chicks when 14 days old	12.4 lbs.	13.1 lbs.
Total deaths during first 14 days	1	9

SUMMARY.

In the first trial with the ventilators open and with an average maximum and minimum outside temperature of 80° and 54.7°, respectively, a better hatch was obtained, and the chicks were stronger when the eggs were not cooled.

In the second trial with closed ventilators, and with a low external temperature, the eggs not cooled hatched better and the chicks were stronger than was the case with the other treatment.

In tests 3, 4, and 5, conducted simultaneously, with closed ventilators, and a high outside temperature, the eggs not cooled hatched better than the cooled eggs in the two Cyphers incubators, and not quite so well in the Prairie State. The chicks, however, from the cooled eggs were materially stronger than the others in all three hatches, as fewer of them died. This would seem to indicate that in warm weather when the circulation of air in the incubator tends to become sluggish, and especially with an insufficient opening of the ventilators, it may be advisable to air the eggs for a reasonable length of time for the purpose of giving the embryos a more adequate supply of oxygen.

It is difficult to conceive of any valid reason for cooling eggs during incubation and thus slowing down the vital processes, and these experiments seem to indicate that the beneficial effects which unquestionably sometimes result from the process of cooling and airing are due to the airing, and that the cooling of eggs during the process of incubation below the proper incubating temperature, when considered by itself, is detrimental.

THE USE OF MOISTURE DURING THE INCUBATION OF HEN EGGS.

Egg shells are porous, and during incubation moisture and carbon dioxide are given off, thus leaving the eggs lighter in weight. The amount of moisture that leaves eggs during artificial incubation can be controlled by regulating the humidity of the air in the incubating chamber. How much moisture should eggs lose for best results? Or in other words, how much should eggs decrease in weight during incubation in order to obtain best hatches and have the chicks most thrifty and vigorous?

In natural incubation the normal loss in weight is shown in the following table taken from bulletin No. 98, of the West Virginia Experiment Station.

Table showing normal loss in weight of 100 eggs in ounces for the first nineteen days of incubation.

1......1.65 ozs.
2......3.31 ozs.
3......4.96 ozs.
4......6.62 ozs.
5......8.28 ozs.
6.....10.00 ozs.
7.....11.72 ozs.
8.....13.44 ozs.
9.....15.16 ozs.
10.....16.88 ozs.
11.....18.60 ozs.
12.....20.33 ozs.
13.....22.10 ozs.
14.....23.88 ozs.
15.....25.66 ozs.
16.....27.44 ozs.
17.....29.21 ozs.
18.....30.99 ozs.
19.....32.77 ozs.

The following tests have been made to determine whether variations in the humidity of the air in the incubating chamber, with its consequent influence upon the loss in weight of eggs, has any influence upon the vigor of the resulting chickens.

TEST 1.

Incubator started September 21, 1907

	CYPHERS No. 3, MOISTURE 836 sq. in. wet sand exposed from start to finish, under egg trays.	CYPHERS No. 3 NO MOISTURE Operated according to directions of manufacturer.
Number of eggs	240	240
Weight of eggs at start	29.87 lbs.	29.82 lbs.
Loss in weight in 17 days	2.6 lbs.	4.32 lbs.
Normal loss as calculated from table	4.38 lbs.	4.38 lbs.
Tested out on 17th day	30 eggs.	27 eggs.
Number of chicks	165	182
Percentage hatch "fertile" eggs	78.5	85.4
Weight of 100 chicks	8.17 lbs.	7.32 lbs.
Number of chicks died in 25 days	30	22
Per cent hatch of all eggs incubated	68.7	75.8

TEST 2.

Incubator started January 19, 1908. Eggs similar in both incubators.

Incubators used,	Cyphers (1906) No Moisture	Prairie State, (Sand Tray) Moisture.
Number of eggs	360	360
Original weight of eggs	44.60 lbs.	44.38 lbs.
Feb. 7th. weight of eggs	37.65 lbs.	39.65 lbs.
Loss in 19 days	6.95 lbs.	4.73 lbs.
Calculated normal loss	7.37 lbs.	7.37 lbs.
Departure from normal	.42 lbs.	2.64 lbs.
Result of hatch.		
Cracked in turning	5	4
Number of chicks	252	244
Percentage hatch of all eggs incubated except those cracked	70.9	68.5
Weight of chicks when removed from incubator, per hundred	7.9 lbs.	8.5 lbs.

Treatment of Chicks.

Marked and placed in two of Rices' Gasoline brooders—One-half of chicks from each incubator in each brooder.

	BROODER NO. 1		BROODER NO. 2.	
	Cyphers	Prairie State	Cyphers	Prairie State
Total deaths until March 24, chicks 24 days old	2	10	25	48

Weight of 100 chicks from broder No. 1, 24 days old............Cyphers 26.2 lbs. Prairie State, 26.3 lbs.

(Chicks injured in brooder no. 2 by accidental escape of gases from gasoline flame into space under hover).

TEST 3.

Incubator started March 2, 1908.

Eggs similar in both incubators.

Incubators used.	No moisture. Cyphers (1906).	Moisture. Prairie State (Sand tray)
Number of eggs incubated	360	360
Original weight of eggs	48.27 lbs.	48.08 lbs.
Weight of eggs March 17	42.88 lbs.	44.05 lbs.
Loss in weight in 15 days	5.39 lbs.	4.03 lbs.
Calculated normal loss	5.77 lbs.	5.77 lbs.
Departure from normal	.38 lbs.	1.74 lbs.

Result of hatch.	No. moisture.	Moisture.
Cracked in turning	5 eggs	5 eggs
Tested out on March 17th	69 eggs	57 eggs
Number of chicks	243	266
Percentage hatch of all eggs incubated except those cracked	68.4	74.9
Weight of chicks per hundred	8.75 lbs.	9.11 lbs.
Toe marked and placed in two brooders.		
Deaths from all causes during first 31 days	39	33

TEST 4.

Incubators started March 29, 1908.

Incubators used.	No moisture. Cyphers (1906).	Moisture. Prairie State. (Sand tray)
Number of eggs incubated	360	360
Original weight of eggs	46.88	47.02
Weight of eggs April 13	41.20	42.97
Loss in weight in 15 days	5.68 lbs.	4.05 lbs.
Calculated normal loss	5.77 lbs.	5.77 lbs.
Departure from normal	.09 lbs.	1.72 lbs.
Result of hatch.		
Cracked in turning	2 eggs	5 eggs
Tested out on 15th day	52 eggs	59 eggs
Number of chicks	273	269
Percentage hatch of all eggs incubated except those cracked	76.2	75.7
Weight of chicks per hundred when removed from incubator	8.56 lbs.	8.92 lbs.
Died from all causes during first 32 days	28	79
Weight of chicks per hundred May 1st, 32 days old	35.96	35.87

TEST 5.

Incubators started March 16, 1908.

Eggs similar in both incubators.

Incubators used.	No moisture. Cyphers (1906)	Moisture. Cyphers with moisture pan.
Number of eggs incubated	360	360
Original weight of eggs	48.02 lbs.	48.02 lbs.

	No moisture	Moisture
Weight of eggs per hundred	13.33 lbs.	13.33 lbs.
Weight of eggs March 31	42.70 lbs.	44.75 lbs.
Loss in weight in 15 days	5.32 lbs.	3.27 lbs.
Calculated normal loss	5.77 lbs.	5.77 lbs.
Departure from normal	.45 lbs.	2.50 lbs.

Result of hatch.

Cracked in turning	5	8
Tested out April 1	62	64
Number of chicks	237	218
Percentage hatch of all eggs incubated except those cracked in turning	66.7%	61.9%
Weight of chicks per hundred when recovered from incubator	9.00 lbs.	9.27 lbs
Weight of chicks May 21 per hundred	57.46 lbs.	63.09 lbs.
Death from all causes to May 21	86	54

TEST 6.

Incubators started April 11, 1908.

Incubators used.	Cyphers No moisture.	Cyphers Moisture.
Number of eggs incubated	360	360
Original weight of eggs	47.05 lbs.	46.98 lbs.
Weight of eggs April 27th	41.05 lbs.	43.10 lbs.
Loss in weight in 16 days	6.00 lbs.	3.88 lbs.
Calculated normal loss	6.17 lbs.	6.17 lbs.
Departure from normal	.17 lbs.	2.29 lbs.

Result of hatch.

Cracked in turning	8	4
Tested out on 16th day	40	62
Number of chicks	289	255
Percentage hatch of all eggs incubated except those cracked in turning	82.1	71.6
Weight of chicks per hundred when removed from incubator	8.22 lbs.	8.89 lbs.
Died from all causes during first 52 days	70 chicks	50 chicks
Weight of chicks per hundred when 52 days old	52.21 lbs.	46.97 lbs.

TEST 7.

Incubators started May 8, 1908.

Incubators used.	Cyphers No moisture.	Cyphers Moisture pans.
Number of eggs incubated	360	360
Weight of 360 eggs	45.85 lbs.	45.82 lbs.
Weight of eggs May 23rd	40.47 lbs.	42.50 lbs.
Loss in weight in 15 days	5.38 lbs.	3.32 lbs.
Calculated normal loss	5.77 lbs.	5.77 lbs.
Departure from normal	.39 lbs.	2.45 lbs.
Result of hatch.		
Cracked in turning	2 eggs.	11 eggs.
Tested out on 15th day	59 eggs.	54 eggs.
Number of chicks	268	259
Percentage hatched of all eggs incubated except those cracked	74.8	74.2
Weight of chicks per hundred when removed from incubator	8.73 lbs.	8.86 lbs.
Died during first 27 days	52	48
Weight of chicks 27 days old, per hundred	21.86 lbs.	22.74 lbs.

TEST 8.

Incubators started May 8, 1908

Incubators used	Cyphers No moisture.	Prairie State Sand tray Moisture.
Number of eggs incubated	360	360
Weight of eggs	46.15 lbs.	46.13 lbs.
Weight of eggs May 23rd	40.70 lbs.	42.60 lbs.
Loss in weight in 15 days	5.45 lbs.	3.53 lbs.
Calculated normal loss	5.77 lbs.	5.77 lbs.
Departure from normal	.32 lbs.	2.24 lbs.
Result of hatch.		
Cracked in turning	3 eggs.	5 eggs.
Tested out on 15th day	60	61
Number of chicks	268	267
Percentage hatched of all eggs incubated except those cracked	75.0	75.2
Weight of chicks per hundred when removed from incubator	8.58 lbs.	9.06 lbs.
Weight of chicks when 27 days old		
Died during first 27 days	91	50
per hundred	21.14 lbs.	22.77 lbs

The following table summarizes the results of the eight tests.

	No moisture used in incubator	Moisture used in incubator
Number of eggs incubated..........	2860	2860
Number of chicks hatched..........	2012	1943
Total loss in weight of eggs......	44.49 lbs.	29.41 lbs.
Normal loss as calculated..........	46.77 lbs.	46.77 lbs.
Departure from normal loss of weight	2.28 lbs.	17.36 lbs.
Average weight of chicks per hundred when removed from incubator....	8.44 lbs.	8.79 lbs.
Average weight of chicks per hundred at second weighing.........	35.7 lbs.	36.2 lbs.
Total number of deaths from all causes	415	402
Per cent dead of all hatched........	20.6	20.6

RESULTS OF THE TEST.

1. In these experiments somewhat more chicks were hatched in the incubators operated without moisture. It is possible, however, that this result may have been due to the operator's more extensive experience in the use of the no-moisture machines, rather than to any injury resulting from the use of moisture.

2. Under the conditions which obtained in these experiments the actual loss in weight of the eggs incubated without added moisture was very nearly normal. while in the case of machines operated with moisture the loss was only about two-thirds of the normal, and yet in spite of this fact there was very little difference in the number of chicks hatched out under the two treatments.

3. In all cases the chicks hatched in the machines with added moisture were heavier when hatched than the chicks hatched without added moisture, and apparently they remained somewhat heavier, for at the second weighing when the chicks were two or three weeks old they averaged one-half pound per hundred chicks heavier than the chicks hatched without moisture.

4. The percentage of deaths from all causes in the case

of the two lots of chickens was exactly the same. Most of the deaths seemed to be due to white diarrhoea or other digestive disturbances.

5. The results of this work seem to indicate that the chick embryos have the power to adapt themselves, to a considerable extent to different degrees of humidity during their development, and consequently to slightly differing percentages of moisture in the tissues of their bodies. The chicks with the lower moisture content seemed to be as vigorous as those containing more moisture, but there are certain limits beyond which this would not be true, and undoubtedly it is the best practice to incubate eggs so that the loss in weight will agree as closely as possible with the normal.

20.679

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 125 JANUARY, 1910

COMMERCIAL FERTILIZERS

COMPLETE REPORT

FOR

1909

By B. H. HITE AND F. B. KUNST

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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Commercial Fertilizers

Complete Report for 1909 Bulletin 125

This Report shows that the fertilizer law of this State is doing everything it was intended to do. Failures to provide the quantity or quality of constituents guaranteed are few. With few exceptions farmers are getting just what the tags tell them they are getting and this is about all that anyone could tell and is certainly as much as any one needs to know in order to purchase fertilizers intelligently. If anybody insists upon purchasing inferior fertilizers, with a sworn statement as to their inferiority pinned all over them by the parties who made them, it is a sad case, of course, but it is beyond the reach of fertilizer legislation.

No one should ever buy a fertilizer without noting carefully the materials from which it is made, for these tell the story so far as quality is concerned and the quality may be a matter of far greater concern than the quantity. The difference between the best of fertilizers and those that are worthless, or worse, may be solely a matter of the materials used. The materials from which every constituent is derived are stated on the tags.

Many persons with the best of motives have urged upon farmers the advisability of purchasing the materials and mixing the fertilizers on the farm. This, at best, is a tedious and laborious operation with the odds always against as good a product as would and should have been prepared in a modern factory, but it is the only way to be certain as to the composition of the fertilizers where the statutes are silent as to the materials from which the various constituents are derived. In this and a number of States requiring a disclosure under oath of the materials used there is little need for "home mixing." The purchaser can usually find among the fertilizers regularly on sale the sort of mixture he wants and he can find on the tags attached to each package as much information as to the composition of the fertilizer as he would have if he had bought the materials and mixed them himself. It ought not to be necessary to add "home mixing" to the already long list of farm labors and it is not necessary where the materials used are known.

Almost every year since the present law of this State went into effect, some other State has either adopted essentially the same provisions or has manifestly done the best it could under the circumstances. During the past year Canada passed a law requiring the same disclosures as to the materials used. It would seem that the necessity for such requirements is appreciated outside of West Virginia, in fact there is no longer very much occasion for doubt as to the sort of legislation that will prevail wherever the farmers get what they want. Farmers are going to know what is in the stuff for which they are exchanging so many millions of cold, hard cash. They have every right to know. There is no other way to know. Fertilizer laws in West Virginia, California, Kansas, Canada, etc., provide this information. These laws simply say to the manufacturer and his agents "State what you are going to sell and sell what you state." Certainly nothing could be much simpler or more nearly fair.

What the purchaser is to do with his fertilizers is, of course, another matter, but it is a matter of so much concern to both makers and users of fertilizers that any good suggestions are always in order.

There is reason to doubt whether half of the fertilizers shipped into this State are really used to the very best advantage. This is no fault of the statute or its enforcement; nor is it the fault of the manufacturers whose duty is done when they provide the thing they said they would provide. The trouble is usually a matter of the conditions under which the fertilizers are used.

The soil work of this Experiment Station shows that large areas of the soils of this State are sour, many of them very sour indeed. These sour soils are not confined to any one section but are to be found all over the State. No fertilizer can have a fair chance on such soils. Farming soils that are in such condition is like working a sick horse; and just about as profitable. Many farmers who have made some little effort to build up these sour soils have been surprised to note what the same fertilizers on the same old fields would do.

Lime is of course the remedy for acidity in soils but lime alone will not build up a sour soil. Almost without exception the sour soils of this State are in need of readily decomposable vegetable matter. Lime and the habit of turning something under is what these sour soils need.

Stable manure may of course be used to supply the vegetable matter, but soil acidity strikes first at the grasses and a sour farm is not likely to produce enough manure to start the work of replenishing the soil's supply of vegetable matter. Green manuring is the quickest, easiest, cheapest and most satisfactory way.

The first problem in green manuring is to get a green crop. Many farmers, when urged to turn something under have replied that if they could grow a crop worth turning under they would have less interest in sour soils or the remedies for them. And just here is the first great opportunity for commercial fertilizers. This is not saying that there are no other uses for commercial fertilizers. Such a statement would be rash indeed. But on the sour soils of this State commercial fertilizers should be used first to grow the green manures. Nobody ever used a commercial fertilizer to better purpose.

But it is one thing to persuade the owner of a sour soil to apply the lime and with the aid of commercial fertilizers to grow the green crop; its another thing to get him to turn it under. To turn under a green crop that is really worth turning under requires more faith in the soil than experience with a sour soil is likely to provide. Unfortunately the experience of the owners of these soils does not as a rule include the period when lime and vegetable matter were not deficient; otherwise it would seem there ought to be very little reluctance to restore such conditions. Be this as it may the owners always believe that their sour soils are simply "worn out," and that if any thing is ever to be gotten out of them that it will have to be put into them; and inasmuch as a heavy green crop is as much as they expect to get out of such soils they see little reason for putting it back into the soil.

The trouble with all of these "worn out" notions is that they ignore the enormous stores of dormant plant food in the mineral particles of the soil, and the ability of decomposing vegetable matter to draw upon these dormant supplies. It is frankly conceded that a very little experience with a sour soil might go a long way in undermining one's faith in such soils as a practical source of plant food, but so long as the vegetable matter is deficient nothing better need be expected as the soil is helpless to draw upon its "inert" stores. If any one doubts the existence of such inert stores or the ability of decomposing vegetable matter to render them available, he has but to recall the effect of stable manure which he has used many times (though not many enough) on these same sour soils. The "lasting effects" so highly prized must be very largely due to plant food not provided directly in the manure. As a matter of fact these inert mineral stores so long ignored and almost forgotten-have been responding, all along, and promptly enough to anything suggesting a return to normal conditions, and it might be worth while to see what these soils would do with something like a normal supply of vegetable matter.

In efforts to discredit commercial fertilizers the fact that they provide no "lasting effects" is often mentioned. This is another way of saying that they contain no vegetable matter or other humus forming materials and this is fortunate indeed for if there is anything that a farmer ought not to have to buy and haul to his fields it is just this sort of materials. But commercial fertilizers do contain in concentrated and quickly available forms the materials that will enable even the poorest soils to grow such quantities of vegetable matter and "lasting effects" as would otherwise be simply out of the question, thus providing an easy and comparatively quick way to reclaim our sour soils. This is the first splendid opportunity for commercial fertilizers in this State, and for this purpose alone, this State could well afford to use many times the quantity now used for all purposes.

It has been stated that lime alone will not build up a sour soil. It should not be forgotten that on sour soils vegetable matter without the lime is just as helpless. There can be no doubt as to the ability of lime and green manuring to wonderfully improve such soils. The only trouble is to get the lime and the green manures into these soils and this would be easy enough and would be done promptly enough if only the owners could be convinced that acidity and the lack of vegetable matter is indeed the fundamental trouble. They are inclined to regard so much "acidity" as a fad rather than a fact and to account for the lack of productiveness by assuming that these soils are simply "worn out." They certainly behave like they were worn out, and, too often the owner knows that if they are not worn out, then in all good conscience they ought to be and to be told that they may be so easily improved seems too good to be true. It is not the sort of news he has been accustomed to hear in regard to such soils.

Humus itself is essentially a sour material. Normal soils contain large quantities of humus, but they are not sour because they always contain enough lime to unite with the humus and so keep the soil sweet. Lime, as it exists in the soil, can be dissolved by water containing carbonic acid. When vegetable matter decomposes in the soil, corbonic acid is formed and absorbed by the soil water, so there is a tendency, always, for lime to be leached out of the soil. As an old saying puts it, "lime sinks in the soil." In a state of nature the soil is always covered with plants of some kind,—always every where penetrated by roots some of which extend many feet into the soil and which pick up the lime that would otherwise get away and carry it to the surface. That is why, in new lands, the surface soil is usually rich in lime. That is why new lands are not sour. When such conditions are replaced by prevailing agricultural practices with their long periods of enforced idleness in the soil, with no living root of any sort to pick up the lime, (unless some weed should insist upon doing its part) it is easy enough to see how the lime can and must get away, and that a time must come when there will not be enough lime to keep the soil sweet. While we have been bemoaning the disappearance of the humus, which could be seen in the change in color, the lime, which we could not see has been even more rapidly getting away. It must be put back.

There is absolutely nothing to be gained by putting off the application of lime to these sour soils. Normal returns are simply out of the question until a normal lime content is provided.

There is nothing to be gained by using ground lime stone instead of the well known burnt lime. As a matter of fact the burnt lime acts more promptly and pound for pound is nearly twice as efficient,—cutting freight bills in two. When the burnt lime is applied it takes up carbonic acid to form the carbonate of lime, which is the material of which the lime stone is composed. The burnt lime has an advantage in that a much finer material is produced by slacking than is possible by grinding the lime rock. Then again the burnt lime being soluble for a time can soak through the soil, thoroughly incorporating itself with the soil. If the burnt lime cannot be had, then marl or ground lime stone or ground oyster shells or any other form of lime (carbonate) should be used.

No one should be afraid to use the burnt lime nor should any one pay double freight bills on the ground lime stone because somebody tells him that the burnt lime will "burn up" the humus. As a matter of fact either form of lime will (as popularly understood) burn up humus. But that is what humus is for;—to "burn up." It is the humus that won't burn up that gets sour and makes trouble.

Humus incidentally performs so many other valuable functions in the soil that we sometimes seem to forget that its one great work is to burn up. In burning up it exerts a more powerful solvent action than any other known agent on the soil's dormant stores of mineral plant food. The only hope for these sour soils is that humus may again be made to burn in them as in the virgin soil.

Strictly speaking it is not the lime but the soil bacteria that burn up the humus and so far as any one has ever been able to suggest these were put into the soil for no other purpose than to "burn up" humus. It so happens that these tiny organisms, like many larger plants can not thrive in a sour soil. The decomposition of the vegetable matter is checked,—with it the ability of the soil to draw upon its own dormant supplies and it is easy to understand why sour soils are always believed to be "worn out." Lime corrects the sourness and so restores the conditions under which the bacteria can proceed with their work.

So long as there is a normal supply of lime in the soil, so that the soil bacteria can do the work for which they were put into the soil, the amount of work they do is determined by the amount of vegetable matter they can find to work on. The virgin soils and new lands rich in vegetable matter were literally alive with bacteria, and the "burning" or decomposition of humus was greater than it has been since. We wish such conditions might have continued and the mistake was in not making some reasonable effort to keep up the supply of humus. This might have been done, and the awful losses by leaching prevented, if vegetable matter of some sort had been kept growing during the long periods each year that these lands have been allowed to remain with no crop of any kind on them. And it might just as well be understood that any serious endeavor to restore, much less to maintain a normal humus supply will find abundant use for all such idle periods. The "burning" or decomposition of vegetable matter provides a way to draw upon the soil's immense stores of dormant plant food but it was manifestly not the intention that these stores should be made available only to be leached from idle lands. Any serious attempt to provide the necessary vegetable matter enforces the practices that prevent the losses.

Farmers suspecting their soils to be sour should send samples of such soils to the Experiment Station. A card will bring instructions for taking the samples and the examination will be made gladly and without any charge whatever. The Station is doing its part in reclaiming these sour soils. The work, or any part of the work is worthy of the best efforts of any man. It means an increase of millions in the productiveness of our lands and everything that goes with such an increase.

Results of Inspection of Commercial Fertilizers for 1909

THE AMERICAN AGRICULTURAL CHEMICAL COMPANY

No. 2 *Rector St., New York,* 741 *Equitable Building,*
Baltimore, Md., and Cleveland, Ohio.

6258. *Big Crop Phosphate.* W. S. Corrothers, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; potash 5. Phosphoric acid from dissolved phosphate rock; patash from manure salt. Found, phosphoric acid, soluble 4.58; reverted, 3.74; insoluble, 0.61; total 8.23; available 8.32; potash 5.33. Chlorine 2.7.

Remark: Source of potash equivalent to kainit.

6264. *A Ground Bone,* Johnson Implement Co., agents, Parkersburg, W. Va. Guarantee: Phosphoric acid, total 25; nitrogen 1.23. Phosphoric Acid from Bone; nitrogen from bone. Found: phosphoric acid, total 24.72; nitrogen, 1.55. Availability of nitrogen, 88.

6305. *Pure Ground Bone.* W. S. Stout, Agent. Harrisville, W. Va. Guarantee: Phosphoric acid, total, 20.60; nitrogen, 3.30. Phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total, 20.56; nitrogen, 3.09; availability of nitrogen, 67.

Remark: Nitrogen, low.

6329. '*Fine Ground Bone.* T. B. Drummond & Co., Agents, Buckhannon, W. Va. Guarantee: Phosphoric acid, total 22.80; nitrogen, 2.47. Phosphoric acid from animal bone; nitrogen from animal bone. Found: phosphoric acid, total, 23.48; nitrogen, 2.68; availability of nitrogen, 92.

6371. ***Fine Ground Bone,*** Siever Hardware Co., Agent, Keyser, W. Va. Guarantee: (as above.) Found: Phosphoric acid, total 23.87; nitrogen 2.57; availability of nitrogen 93.

6429. *Bone Meal,* H. C. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid, total, 13.75; nitrogen, 1.65. Phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total, 17.27; nitrogen 2; availability of nitrogen 90.

6266. *The A. A. C. Co's. Special Potash Mixture,* Johnson Implement Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, soluble 3.50; reverted, 1.50; insoluble, 1.50; total, 6.50; available, 5; potash 10; nitrogen 0.82. Phosphoric acid 4-5 phosphate rock, 1-5 bone tankage; nitrogen 6-7 bone tankage, 1-7 garbage tankage; potash from muriate of potash. Found: phosphoric acid, soluble 2.46; reverted, 3.28; insoluble 1.27; total 7.01; available 5.74; nitrogen 0.95; potash, 10.92; availability of nitrogen 83; chlorine 0.9.

6313. *High Grade Dissolved Bone and Potash,* A. G. Chrislip, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 5. Phosphoric acid from dissolved phosphate rock; potash 1-4 to 3-4 from muriate of potash, 1-4 to 3-4 from manure salts. Found, phosphoric acid, soluble, 7.33; reverted, 4.31; insoluble 0.37; total 12.01; available 11.64; potash 3.37; chlorine 2.3.

Remark: Potash low. Source of potash equivalent to manure salt.

6302. *Wheat, Corn and Grass Mixture,* J. L. Woodyard, Agent, Pruntytown, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.41; potash 2. Phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to 1-4 garbage tankage, 3-4 to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble 3.47; reverted 4.33; insoluble 0.96; total 8.76; available 7.80; nitrogen 0.47; potash 2; availability of nitrogen 72; chlorine 5.2.

Remark: Chlorine excessive.

6316. *A. A. C. Co's. Corn, Oats and Buckwheat Fertilizer,* W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, soluble, 4; reverted 2; insoluble 1; total 7; available 6; potash 3; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble, 2.07; reverted, 4.26; insoluble, 0.35! total, 6.68; available, 6.33; potash 3.32; chlorine 5.1.

Remark: Chlorine excessive.

6293. *Superphosphate,* Marlinton Supply Co., Agent, Marlinton, W. Va. Guarantee: Phosphiric acid, soluble 14; reverted 2; insoluble 1; total 17; available 16; Phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 15.15; reverted 2.55; insoluble 0.35; total 18.05; available 17.70.

6338. *Bone Potash Fertilizer,* G. T. Howell, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted, 2; insoluble, 1; total 9; available 8; potash 5. Phosphoric acid from dissolved phosphate rock; potash from manure salt. Found: Phosphoric acid, soluble, 3.53; reverted, 4.35; insoluble, 0.69; total, 8.57; available 7.88; potash 4.92; chlorine 2.9.

Remark: Source of potash equivalent to kainit.

6400. *Genuine German Kainit,* R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: Potash, 12. Potash from Kainit. Found: Potash, 11.86; chlorine 2.7.

6452. *A. A. C. Co's. Dissolved Bone and Potash,* A. P. Russell & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 2; potash 2; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble 5.60; reverted, 3.28; insoluble, 0.34; total, 9.22; available, 8.88; potash 5.90; chlorine 3.1.

Remark: Chlorine excessive.

6342. *Gem. Alkaline Phosphate,* T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble, 4; reverted, 2; insoluble 1; total 7; available 6; potash 3. Phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble 1.69; reverted 4.45; insoluble 0.49; total 6.63; available 6.14; potash 3.85; Chlorine 4.3.

Remark: Chlorine excessive.

6265. *Bradley's Corn and Wheat Phosphate,* Johnson Implement Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, soluble, 5.50; reverted 2.50; insoluble 1.50; total 9.50; available 8; potash 2; nitrogen 0.82; Phosphoric Acid ⅘; phosphate rock, ⅕ bone tankage; nitrogen 6-7 bone tankage; 1-7 garbage tankage, potash from muriate of potash. Found: Phosphoric acid, soluble, 5.18; reverted 3.48; insoluble 1.47; total 10.13; available 8.66; nitrogen 1.01; potash 2.33; availability of nitrogen 70; chlorine 1.

6390. *Bradley's Niagara Phosphate,* Thomas Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 2; insoluble 1; total 8; available 7; nitrogen 0.82; potash 1; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 3.99; reverted 4.04; insoluble 0.96; total 8.99; available 8.03; nitrogen 1.05; potash 1.26; availability of nitrogen 77; chlorine 7.3.

Remark: Chlorine excessive.

6391. *Bradley's Bean and Potato Phosphate,* Thomas Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 4; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage ¾ to 9-10 animal tankage; potash from ¼ to ¾ from manure salt and ¼ to ¾ kainit. Found: Phosphoric acid, soluble, 5.82; reverted 2.11; insoluble 1.20; total 9.13; available 7.93; nitrogen 0.96; potash 4.15; availability of nitrogen 78; chlorine 2.2.

6263. *Bradley's Justice Brand Phosphate,* Johnson Implement Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, soluble 9; reverted 3; insoluble 1.50; total 13.50;

available, 12. Phosphoric acid from phosphate rock. Found: Phosphoric acid, soluble, 6.37; reverted 6.07; insoluble 2.96; total 15.40; available 12.44.

6310. *Canton Chemical Potato and Tobacco Manure,* W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; nitrogen 1.24; potash 5. Phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage and ¾ to 9-10 animal tankage; potash ¼ to ¾ manure salt and ¼ to ¾ kainit. Found: Phosphoric acid, soluble, 4.87; reverted 3.58; insoluble 3.15; total 11.60; available 8.45; nitrogen 1.32; potash 2.07; availability of nitrogen 87; chlorine 1.9.

Remark: Potash low. *

6363. *Canton Chemical Harrow Brand Crop Grower,* J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 1. Phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage and ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 5.42; reverted 3.61; insoluble 1.18; total 10.21; available 9.03; nitrogen 1; potash 1.37; availability of nitrogen 80; chlorine 6.

Remark: Chlorine excessive.

6364. *Canton C. C. C. Special Compound,* J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 2.06; potash 6; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ from sulphate of ammonia, 1-10 to ¼ garbage tankage, ¼ to ¾ from animal tankage; potash from muriate of potash. Found: Phosphoric acid, soluble 4.54; reverted 3.88; insoluble 1.60; total 10.02; available 8.42; nitrogen 1.96; potash 6.10; availability of nitrogen 89; chlorine 1.2.

6366. *Canton Chemical Baker's Special Wheat, Corn and Grass Mixture,* Siever Hardware Company, Agent, Keyser, W. Va. Guarantee: Soluble Phosphate acid, 7; reverted 2; insoluble 1; total 10; available 9; nitrogen, 0.82; potash 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ from garbage tankage, ¾ to 9-10 from animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 5.46; reverted, 3.64; insoluble 1.30; total 10.40; available 9.10; nitrogen 1.03; potash 2.21; availability of nitrogen 80; chlorine 4.5.

Remark: Chlorine excessive.

6368. *Canton Chemical Soluble Bone and Potash,* J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble 5.28; reverted 4.29; insoluble 0.79; total 10.36; available 9.57; potash 2.24: chlorine 3.7.

Remark: Phosphoric acid low. Chlorine excessive.

6369. *Canton Chemical Baker's Dissolved S. C. Bone,* J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2; insoluble 1; total 15; available 14; Phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 10.95; reverted 4.28; insoluble 0.81; total 16.04; available 15.23.

6370. *Canton Chemical Game Guano,* J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.65; potash 2. Phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble, 4.36; reverted, 3.65; insoluble, 1.43; total 9.44; available 8.01; nitrogen 1.73; potash 2.12; availability of nitrogen 84; chlorine 3.3.

Remark: Chlorine excessive.

6428. *Canton Chemical Eagle Phosphate,* Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 2; insoluble 1; total 8; available 7; nitrogen 0.82; potash 1. Phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: phosphoric acid, soluble, 4.60; reverted 3.03; insoluble 0.92; total 8.55; available 7.63; nitrogen 0.85; potash 1.27; availability of nitrogen 76; chlorine 7.9.

Remark: Chlorine excessive.

6347. *Cleveland Dryer XXX Phosphate,* Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2; insoluble 1; total 15; available 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble, 11.96; reverted, 3.52; insoluble 0.65; total 16.13; available 15.48.

6365. *Cleveland Dryer Forest City Buckeye,* Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid. soluble 7; reverted 2; insoluble 1; total 10; available 9; nitrogen 2.47; potash 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen ½ to ¾ from animal tankage, 1-10 to ¼ sulphate of ammonia, 1-10 to ¼ fish; potash ¼ to ¾ from manure salt, ¼ to ¾ kainit. Found: Phosphoric acid, soluble, 5.18; reverted, 3.70; insoluble 2.01; total 10.89; available 8.88; nitrogen 2.47; potash 2.33; availability of nitrogen 90; chlorine 1.8.

6450. *Cleveland Dryer Horsehead Phosphate and Potash,* Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2. Phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble 7.37; reverted 3.41; insoluble 0.41; total 11.19; available 10.78; potash 3.08; chlorine 4.7.

Remark: Chlorine excessive.

6451. *Cleveland Dryer Horsehead Phosphate,* Chester Hardware Co., Agent, Chester, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10. Phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 7.25; reverted, 5.43; insoluble 3.43; total 16.11; available 12.68.

rock and dissolved animal bone; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble 5.18; reverted, 3.27; insoluble 1.16; total 9.61; available 8.45; nitrogen 1.12; potash 2.25; availability of nitrogen 82; chlorine 3.8.

Remark: Chlorine excessive.

6332. *Great Eastern Vegetable, Vine and Tobacco,* M. C. Jackson, Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 2.05; potash 3; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen ½ to ¾ animal tankage, 1-10 to ¼ fish; ¼ to 1-10 sulphate of ammonia; potash ¼ to¾ manure salts; ¼ to ¾ kainit. Found: Phosphoric acid, soluble 5.80; reverted 2.78; insoluble 1.33; total 9.91; available 7.58; nitrogen 2.10; potash 3.20; availability of nitrogen 91; chlorine 1.

Remark: Phosphoric acid low.

6367. *Great Eastern Corn Fertilizer,* Farmington Mill Co., Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble, 6; reverted 2; insoluble 1; total 9; available 8; nitrogen .82; potash 4; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash ¼ to ¾ manure salts, ¼ to ¾ kainit. Found: Phosphoric acid, soluble 4.80; reverted 3.35; insoluble 1.06; total 9.21; available 8.14; nitrogen 0.89; potash 4.39; availability of nitrogen 78; chlorine 2.2.

6274.. *Lazaretto Special Potato and Tobacco Fertilizer,* Mossman Brothers, Agent, Huntington, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen .82; potash 4; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash ¼ to ¾ manure salts and ¼ to ¾ kainit. Found: Phosphoric acid. soluble 4.76; reverted 4.08; insoluble 1.64; total 10.48; available 8.84; nitrogen, 0.89; potash 4.58; availability of nitrogen 76; chlorine 0.9.

6325. *Lazaretto High Grade Dissolved Bone and Potash,* A. G. Chrislip, Agent, Philippi. W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 2; insoluble 1; total 13; available 12; potash 5; phosphoric acid from dissolved phosphate rock; potash from muriate of potash. Found: Phosphoric acid, soluble 8.53; reverted 3.47; insoluble 0.69; total 12.69; available 12: potash 5.18; chlorine 1.7.

Remark: Chlorine excessive.

6426. *Lazaretto Bone Compound,* T.. B. Drummond, Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 2; insoluble 1; total 10; available 9; nitrogen 1.03; potash 3. Phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash ¼ to ¾ manure salts and ¼ to ¾ kainit. Found: Phosphoric acid, soluble 6.77; reverted 3.03; insoluble 1.43; total 11.23; available 9.80; nitrogen 1.17; potash 3.39; availability of nitrogen 76; chlorine 1.6.

6331. *Lazaretto Dissolved Bone Phosphate,* T. B. Drummond, Agent, Buckhannon, W. Va. Guaranteed: Phosphoric caid, soluble 12; reverted 2; insoluble 1; total 15; available 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 11.80; reverted 3.53; insoluble 0.56; total 15.89; available 15.33.

6276. *Maryland Bono Superphosphate,* J. L. Woodyard, Agent, Pruntytown, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2. Phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble 6.60; reverted 3.91; insoluble 0.90; total 11.41; available 10.51; potash 2.26; chlorine 4.4.

Remark: Chlorine excessive.

6277. *Maryland Special Compound for Potatoes and Tobacco,* J. L. Woodyard, Agent, Pruntytown, W. Va. Guarantee: Phosphoric Acid: Soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.65; potash 10; phosphoric acid from

A. G. Chrislip, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2. Phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble 5.88; reverted 4.07; insoluble 0.86; total 10.81; available 9.95; potash 2.26; chlorine 4.2.

Remark: Chlorine excessive.

6427. *Williams & Clark's Royal Bone Phosphate,* Wheeling Implement & Buggy Co., Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.03; potash 2. Phosphoric acid from dissolved animal bone and dissolved phosphate rock. Nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble 6.52; reverted, 2.66; insoluble 1.88; total 11.16; available 9.28; nitrogen 97; potash 2.03; availability of nitrogen 78; chlorine 1.9.

6242. *Zell's Little Giant,* Benson Jacobs, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 2; insoluble 1; total 8; available 7; nitrogen 0.82; potash 1; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble 3.49; reverted 3.77; insoluble 1.62; total 8.88; available 7.26; nitrogen 0.93; potash 1.30; availability of nitrogen 76; chlorine 7.

Remark: Chlorine excessive.

6285. *Zell's Economizer Phosphate,* Carmen & Liggett, Agent, Wellsburg, W. Va. Guarantee: Phosphoric Acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 2. Phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble 4.57; reverted 3.75; insoluble 1.91; total 10.23; available 8.32; nitrogen 1.13; potash 2.75; availability of nitrogen 82; chlorine 1.7.

6243. *Zell's Electric Phosphate,* Benson Jacobs, Agent Little Falls, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble 5.65; reverted 4.36; insoluble 0.83; total 10.84; available 10.01; potash 2.10; chlorine 3.8.

Remark: Chlorine excessive.

6308. *Zell's Dissolved Bone Phosphate,* Philippi Mill Co., Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2; insoluble 1; total 15; available 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 11.54; reverted 3.67; insoluble 0.69; total 15.90; available 15.21.

6334. *Zell's Ammoniated Bone Superphosphate, R.* Hunter, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.65; potash 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid soluble 5.07; reverted 3.34; insoluble 1.22; total 9.63; available 8.41; nitrogen 1.63; potash 2.25; availability of nitrogen 86; chlorine 3.3.

Remark: Chlorine excessive.

6357. *Zell's Special Compound for Potatoes and Vegetables,* Parley Deberry, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2; insoluble 1; total 9; available 8; nitrogen 2.47; potash 4; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen ½ to ¾ animal tankage, 1-10 to ¼ sulphate of ammonia, 1-10 to ¼ fish; potash from muriate of potash. Found: Phosphoric acid, soluble 5.54; reverted 2.77; insoluble 1.60; total 9.91; available 8.31; nitrogen 2.47; potash 3.70; availability of nitrogen 91; clorine 1.1.

Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 0.50; total 10.50; available 10; potash 5; phosphoric acid from acid phosphate; potash ⅖ to ⅗ kainit, ⅖ to ⅗ muriate of potash. Found: Phosphoric acid, soluble 6.37; reverted 3.48; insoluble 0.23; total 10.08; available 9.85; potash 4.86; chlorine 2.3.

Remark: Chlorine excessive.

6358. *Phosphate and Potash No. 2,* R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 0.50; total 8:50; available 8; potash 6; phosphoric acid fro macid phosphate; potash ⅖ to ⅗ kainit, ⅖ to ⅗ muriate of potash. Found: Phosphoric acid, soluble 4.89; reverted 3.08; insoluble 0.13; total 8.10; available 7.97; potash 5.32; chlorine 2.8.

Remark: Source of potash equivalent to kainit.

6378. *Phosphate and Potash No. 2,* R. N. Stewart & Sons. Agents, Martinsburg, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble 4.62; reverted 2.82; insoluble 0.19; total 7.63; available 7.44; potash 5.15; chlorine 2.8.

Remark: Source of potash equivalent to kainit; phosphoric acid low.

6379. *Phosphate and Potash No. 1,* R. N. Stewart & Sons, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 0.50; total 10.50; available 10; potash 2; phosphoric acid from acid phosphate; potash ⅖ to ⅗ from kainit, ⅖ to ⅗ muriate of potash. Found: Phosphoric acid soluble 7.19; reverted 2.24; insoluble 0.23; total 9.66; available 9.43; potash 2.26; chlorine 2.6.

Remark: Source of potash equivalent to kainit.

6380. *Grain Grower,* R. N. Stewart & Sons, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 0.50; total 8.50; available 8; nitrogen 1.65; potash 2; phosphoric acid ⅖ to ⅗ acid phosphate, ⅖ to ⅗ animal bone meal; nitrogen 1-10 to 2-10 animal bone meal, 8-10 to 9-10 animal tankage; potash ⅕ to ⅖ muriate of potash, ⅗ to ⅘ kainit. Found: Phosphoric acid, soluble 4.53; reverted 3.15;

insoluble 0.67; total 8.35; available 7.68; nitrogen 1.46; potash 2.17; availability of nitrogen 84; chlorine 3.

Remark: Phosphoric acid low; nitrogen low; source of potash equivalent to kainit.

6418. *Wheat and Clover,* H. C. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 5; phosphoric acid from acid phosphate; potash ⅓ to ⅔ from kainit, ⅓ to ⅔ from muriate. Found: Phosphoric acid, soluble 7.09; reverted 2.61; insoluble 0.47; total 10.17; available 9.70; potash 4.88; chlorine 2.7.

Remark: Source of potash equivalent to kainit. Phosphoric acid low.

BAUGH & SONS COMPANY,

Philadelphia, Pa., and Norfok, Va.

6261. *Baugh's High Grade Acid Phosphate,* sent in for analysis by L. Riggleman, Reedsville, W. Va. Guarantee: Phosphoric acid, insoluble 1; total 15; available 14. Phosphoric acid from dissolved rock. Found: Phosphoric acid, soluble 12.52; reverted 2.64; insoluble 0.83; total 15.99; available 15.16.

6388. *Baugh's High Grade Acid Phosphate,* T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: (As above.) Found: Phosphoric acid, soluble 14.57; reverted 3.02; insoluble 0.10; total 17.69; available 17.59.

6262. *Baugh's Soluble Alkaline Superphosphate,* sent in for analysis by L. Riggleman, Reedsville, W. Va. Guarantee: Phosphoric Acid, insoluble 1; total 11; available 10; potash 2; phosphoric acid from dissolved rock; potash from kainit. Found: Phosphoric acid, soluble 1.65; reverted 9.13; insoluble 0.90; total 11.68; available 1078; potash 2.33; chlorine 3,2.

Remark: Chlorine excessive.

6360. *Baugh's Double Eagle $25 Phosphate, a Raw Bone Superphosphate,* Offutt & Lakin, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, insoluble 2; total 10:50; available

8:50; nitrogen 1.65; potash 1; phosphoric acid from phosphate rock; nitrogen ⅔ animal tankage, ⅓ sulphate of ammonia; potash from kainit. Found: Phosphoric acid, soluble 5.69; reverted 3; insoluble 1.29; total 9.98; available 8.69; nitrogen 1.78; potash 1.32; availability of nitrogen 76; chlorine 3.2.

Remark: Chlorine excessive.

6372. *Baugh's General Crop Grower,* T. P Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric Acid, insoluble 2; total 10; available 8; nitrogen 0.82; potash 1; phosphoric acid from phosphate rock; nitrogen ½ animal tankage, ½ garbage tankage; potash from kainit. Found: Phosphoric acid soluble 1.50; reverted 7.34; insoluble 2.56; total 11.40; available 8.84; nitrogen 1.13; potash 1.43; availability of nitrogen 78; chlorine 3.

6373. *Baugh's Export Bone with Potash,* T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric Acid, total, 11; nitrogen 1.65; potash 2; phosphoric acid from animal bone; nitrogen from animal bone; potash ½ from muriate of potash, ½ from kainit. Found: Phosphoric acid, total 11.72; nitrogen 2.02; potash 2.43; availability of nitrogen 91; chlorine 3.6.

Remark: Source of potash equivalent to kainit. Chlorine excessive.

6374. *Baugh's Pure Dissolved Animal Bones,* T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric Acid, insoluble 3; total 16; available 13; nitrogen 2.06; phosphoric acid from animal bone; nitrogen from animal bone. Found; Phosphoric acid, soluble 6.73; reverted 7.71; insoluble 0.45; total 14.89; available 14.44; nitrogen 2.44; availability of nitrogen 89.

6275. *Baugh's Complete Animal Bone Fertilizer,* T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Insoluble 2; total 10; available 8; nitrogen 1.65; potash 5; phosphoric acid from phosphate rock; nitrogen ⅔ animal tankage, ⅓ sulphate of ammonia; potash ½ from muriate of potash, ½ from kainit. Found: Phosphoric acid, soluble 2.80; reverted

5.55; insoluble 1.91; total 10.26; available 8.35; nitrogen 1.66; potash 5.15; availability of nitrogen 88; chlorine 1.8.

6376. *Baugh's 16% Acid Phosphate,* T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, insoluble 1; total 17; available 16. Phosphoric acid from dissolved rock. Found: Phosphoric acid, soluble 14.30; reverted 3; insoluble 0.18; total 17.48; available 17.30.

6389. *Baugh's Special Potato Manure,* N. C. Musgrave, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, insoluble 2; total 7; available 5; nitrogen 1.65; potash 10; phosphoric acid from phosphate rock; nitrogen ⅔ animal tankage, ⅓ sulphate of ammonia; potash from muriate of potash. Found: Phosphoric acid, soluble 2.02; reverted 3.44; insoluble 0.87; total 6.33; available 5.46; nitrogen 1.72; potash 10.42; availability of nitrogen 89; chlorine 1.2.

6392. *Baugh's Peninsula Grain Producer,* R. T. Lowndes, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, insoluble 2; total 10; available 8; nitrogen 1; potash 2. Phosphoric acid from phosphate rock; nitrogen ½ animal tankage, ½ garbage tankage; potash ½ from muriate of potash and ½ from kainit. Found: Phosphoric acid, soluble, 6.11; reverted 3.08; insoluble 2.04; total 11.23; available 9.19; nitrogen 1.80; potash 2.20; availability of nitrogen 82; chlorine 2.5.

Remark: Source of potash equivalent to kainit.

6393. *Baugh's Excelsior Guano,* West Virginia Implement Co., Agent, Elkins, W. Va. Guarantee: Phosphoric Acid, insoluble 2; total 10; available 8; nitrogen 1; potash 3; phosphoric acid from phosphate rock; nitrogen ½ animal tankage, ½ garbage tankage; potash ½ muriate of potash, ½ kainit. Found: Phosphoric acid, soluble 1.99; reverted 6.89; insoluble 1.30; total 10.18; available 8.88; nitrogen 1.06; potash 4.39; availability of nitrogen 57; chlorine 1.5.

6394. *Baugh's Raw Bone Meal Warranted Pure,* West Virginia Implement Co., Agent, Elkins, W. Va. Guarantee: Phosphoric acid, total 21.50; nitrogen 3.70; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total, 21.65; nitrogen 3.66; availability of nitrogen 62.

BOWKER'S FERTILIZER COMPANY,

Boston, New York and Cincinnati.

6395. *Bowker's Harvest Bone,* Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 1; phosphoric acid from dissolved animal bone and phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble 5.19; reverted 3.24; insoluble 1.47; total 9.90; available 8.43; nitrogen 0.79; potash 1.31; availability of nitrogen 75; chlorine 6.2.

Remark: Chlorine excessive.

6396. *Bowker's Dissolved Bone & Potash,* Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2; phosphoric acid from dissolved phosphate rock; potash from kainit. Found: Phosphoric acid, soluble 5.59; reverted 4.30; insoluble 0.93; total 10.82; available 9.89; potash 2.08; chlorine 4.3.

Remark: Chlorine excessive.

6397. *Bowker's Potash Fertilizer,* Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 5; phophoric acid from dissolved phosphate rock; potash ¼ to ¾ muriate of potash; ¼ to ¾ manure salt. Found: Phosphoric acid, soluble 5.59; reverted 4.59; insoluble 0.98; reverted 11.16; avaivable 10.18; potash 5.15; chlorine 2.

6425. *Bowker's Bone Meal,* Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, total 25; nitrogen

1.23. Phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 22.22; nitrogen 1.86; availability of nitrogen 93.

Remark: Phosphoric acid low.

GRIFFITH & BOYD COMPANY,

Baltimore, Md.

64.39. *Peerless Fertilizer,* H. C.. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 1; insoluble 1; total 9; available 8; nitrogen 0.29; potash 2; phosphoric acid from low grade bone tankage and rock almost entirely; nitrogen from low grade bone tankage; potash from kainit. Found: Phosphoric acid, soluble 5.59; reverted 3.88; insoluble 1.79; total 11.26; available 9.47; nitrogen 0.46; potash 2.46; availability of nitrogen 55; chlorine 3.4.

Remark: Chlorine excessive.

6440. *Gem Phosphate,* H. C. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 5, reverted 1.50; insoluble 0.50; total 7; available 6.50; potash 3; phosphoric acid from rock; potash from kainit. Found: Phosphoric acid, soluble 4.83; reverted 3.92; insoluble 1.85; total 10.60; available 8.75; potash 2.98; chlorine 2.8.

6381. *XX Potash Manure,* T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid,. soluble 7; reverted 3; insoluble 1; total 11; available 10; potash 5; phosphoric acid from S. C. Rock; potash ½ from muriate of potash, ½ from kainit. Found: Phosphoric acid, soluble 6.84; reverted 3.46; insoluble 1.26; total 11.56; abailable 10.30; potash 4.93; chlorine 1.6.

6382. *Special Grain Grower,* T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric Acid, soluble 7; reverted 3; insoluble 1; total 11; available 10; potash 2; phosphoric acid from S. C. Rock; potash from kainit. Found:

Phosphoric acid, soluble 4.26; reverted 5.69; insoluble 2.04; total 11.99; available 9.95; potash 2.02; chlorine 3.4.

Remark: Chlorine excessive.

6377. *Farmer's Potato Manure,* T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 1; insoluble 1; total 9; available 8; nitrogen 85; potash 9; phosphoric acid ⅓ S. C. Rock, ⅓ low grade bone tankage, ⅓ dissolved bone; nitrogen ⅓ low grade bone tankage, ⅓ dissolved bone, ⅓ fish; potash ½ muriate of potash, ¼ sulphate of potash, ¼ kainit. Found: Phosphoric acid, soluble 4.81; reverted 4.32; insoluble 1.50; total 10.63; available 9.13; nitrogen .87; potash 8.48; availability of nitrogen 83; chlorine 1.2.

Remark: Potash low.

S. M. HESS & BROTHER,

Philadelphia, Pa.

6312. *Soluble Bone,* F. A. Simpson, Agent. Philippi, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2; insoluble 1; total 15; available 14. Phosphoric acid from acid phosphate. Found: Phosphoric acid, soluble 11.83; reverted 3.64; insoluble 0.52; total 15.99; available 15.47.

6317. *Keystone Bone Phosphate,* F. A. Simpson, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 1; phosphoric acid from acid phosphate; nitrogen from animal tankage; potash from muriate of potash. Found: Phosphoric acid, soluble 4.94; reverted 3.12; insoluble 1; total 9:06; available 8.06; nitrogen 0.81; potash 1.18; availability of nitrogen 79; chlorine 6.5.

Remark: Chlorine excessive.

6318. *Soluble Bone and Potash,* F. A. Simpson, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2; phosphoric acid from acid phosphate. Potash from Kainit. Found:

Phosphoric acid, soluble 5.69; reverted 3.99; insoluble 0.86; total 10.54; availble 9.68; potash 2.02; chlorine 4.4.

Remark: Phosphoric acid low; chlorine excessive.

6341. *Emperor Phosphate,* F. A. Simpson, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 1; phosphoric acid from acid phosphate; potash from kainit. Found: Phosphoric acid, soluble 6.51; reverted 3.90; insoluble 0.75; total 11.16; available 10.41; potash 1.29; chlorine 7.1.

Remark. Chlorine excessive.

THE HUBBARD FERTILIZER COMPANY.

Baltimore, Md.

6355. *Hubbard's Soluble Bone Phosphate,* C. E. Casler, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 4; insoluble 1.50; total 15.50; available 14; phosphoric acid from high grade Florida phosphate. Found: Phosphoric acid, soluble 12.95; reverted 3.82; insoluble 0.86; total 17.63; available 16.77.

6356. *Hubbard's Climax Bone Superphosphate,* C. E. Casler, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 2; insoluble 1; total 8; available 7; nitrogen 1; potash 4; phosphoric acid 3/5 from high grade Florida phosphate 1/5 tankage and 1/5 from dissolved animal bone; nitrogen 1/2 bone tankage and 1/2 blood and animal matter; potash 1/2 from sylvanit and 1/2 from kainit. Found: Phosphoric acid, soluble 3.91; reverted 4.80; insoluble 1.23; total 9.94; available 8.71; nitrogen 1.06; potash 4.11; availability of nitrogen 66; chlorine 2.4.

6430. *Hubbard's Oriental Phosphate,* H. C. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 3; insoluble 1; total 9; available 8; nitrogen 1; potash 2; phosphoric acid 3/5 from high grade Florida phosphate and 1/5 from tankings and 1/5 from dissolved animal bone;

nitrogen ½ bone tankings and ½ blood and animal matter; potash ½ from sylvanit and ½ from kainit. Found: Phosphoric acid, soluble 1.54; reverted 6.60; insoluble 1.45; total 9.59; available 8.14; nitrogen 1.03; potash 3.02; availability of nitrogen 81; chlorine 3.4.

JARECKI CHEMICALL COMPANY.

Cincinnati, Ohio.

6275. *No. 1 Guano with Phosphate and Potash,* Damron Feed & Seed Co., Agent, Huntington, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 2; phosphoric acid from mineral phosphate bone and animal tankage; nitrogen from animal tankage; potash from muriate. Found: Phosphoric acid, soluble 5.32; reverted 3.69; insoluble 2.26; total 11.27; available 9.01; nitrogen 0.92; potash 2.09; availability of nitrogen 67; chlorine 0.7.

6339. *No. 1 Guano with Phosphate and Potash,* sent in for analysis by S. A. Leach & Son Co., Red House, W. Va. Guarantee: (as above). Found: Phosphoric acid soluble 5.37; reverted 4.08; insoluble 2.23; total 11.68; available 9.45; nitrogen 0.99; potash 2.12; availability of nitrogen 58; chlorine 0.8.

6296. *Raw Bone and Guano Mixture,* W. F. Sill, Agent, Pennsoboro, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 3; insoluble 5; total 16; available 11; nitrogen 1.65; potash 1; phosphoric acid from bone and animal tankage; nitrogen from animal tankage and bone; potash from muriate. Found: Phosphoric acid, soluble 2.86; reverted 12.78; insoluble 4.76; total 20.40; available 15.64; nitrogen 1.88; potash 1.10; availability of nitrogen 85; chlorine 0.8.

6303. *Fish Phosphate and Potash Tobacco and Potato Food,* W. F. Sill, Agent, Pennsboro, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 4; phosphoric acid from mineral phosphate, bone and animal tankage; nitrogen from animal tankage;

potash from muriate. Found: Phosphoric acid, soluble 5.30; reverted 2.89; insoluble 2.07; total 10.26; available 8.19; nitrogen 0.91; potash 4.05; availability of nitrogen 71; chlorine 1.

6340. *Fish Phosphate and Potash Tobacco and Potato Food,* sent in for analysis by A. S. Leach & Sons Co., Red House, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble 4.82; reverted 2.99; insoluble 2.03; total 9.84; available 7.81; nitrogen 0.89; potash 4.21; availability of nitrogen 71; chlorine 1.

6304. *Acid Phosphate,* W. F. Sill, Agent, Pennsboro, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2; insoluble 1; total 15; available 14; phosphoric acid from phosphate rock. Found: Phosphoric acid, soluble 9.87; reverted 4.72; insoluble 1.80; total 16.39; available 14.59.

MARIETTA BONE & PHOSPHATE COMPANY,

Marietta, Ohio.

6282. *Potato and Truck Special,* C. F. Braumlich, Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, insoluble 2; total 10; available 8; nitrogen 2.05; potash 6; phosphoric acid from acid phosphate and animal tankage; nitrogen from animal tankage and nitrate of soda; potash from muriate. Found: Phosphoric acid, soluble 2.52; reverted 6.32; insoluble 1.78; total 10.62; available 8.84; nitrogen 1.46; potash 5.61; availability of nitrogen 92; chlorine 0.9.

Remark: Nitrogen low; potash low.

6283. *Acid Phosphate,* C. F. Braumlich, Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, insoluble 2; total 14; available 12; phosphoric acid from acid phosphate. Found: Phosphoric acid, soluble 10.69; reverted 3.12; insoluble 0.42; total 14.23; available 13.81.

6284. *Pure Raw Bone,* C. H. Becker, Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, total 20; nitrogen 3.80;

phosphoric acid from bone; nitrogen from bone. Found: Phosphoric acid, total 20.46; nitrogen 3.90; availability of nitrogen 79.

THE MILLER FERTILIZER COMPANY,

Baltimore, Md.

6294. *Hustler Phosphate,* F. L. Beard, Agent, Marlinton, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 3; insoluble 1.50; total 9.50; available 8; nitrogen 0.83; potash 1; phosphoric acid ⅙ from tankage, 5-6 from acid phosphate; nitrogen ⅕ sulphate of ammonia, ⅘ from 4 % tankage; potash from kainit. Found: Phosphoric acid, soluble 4.57; reverted 3.66; insoluble 0.69; total 8.92; available 8.23; nitrogen 0.95; potash 1.52; availability of nitrogen 77; chlorine 2.9.

6295. *M. B. S.,* F. L. Beard, Agent, Marlinton, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 2; insoluble 1.50; total 8.50; available 7; nitrogen 0.83; potash 3; phosphoric acid ⅙ from tankage, 5-6 from acid phosphate; nitrogen ⅕ from sulphate of ammonia, ⅘ from 4 % tankage; potash from manure salt. Found: Phosphoric acid, soluble 3.62; reverted 6.09; insoluble 0.52; total 10.23; available 9.71; nitrogen 1.08; potash 3.42; availability of nitrogen 83; chlorine 3.3.

Remark: Source of potash equivalent to kainit; chlorine excessive.

6301. *W. G. Phosphate,* F. L. Beard, Agent, Marlinton, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 2; insoluble 1.50; total 8.50; available 7; nitrogen 0.42; potash 1; phosphoric acid ⅕ from tankage, ⅘ from acid phosphate, nitrogen from 4% tankage; potash from kainit. Found: Phosphoric acid soluble, 3.51; reverted 4.10; insoluble 0.36; total 7.97; available 7.61; nitrogen 0.54; potash 1.37; availablity of nitrogen 69; chlorine 3.

6383. *Ammoniated Dissolved Bone,* Thomas Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble 5, reverted 3, insoluble 1.50; total 9.50; available 8; nitrogen

1.65; potash 2; phosphoric acid ⅓ from bone tankage, ⅔ from acid phosphate; nitrogen ⅓ from sulphate of ammonia, ⅔ from bone tankage; potash ½ from kainit, ½ from manure salt. Found: Phosphoric acid, soluble, 5.01; reverted 3.25; insoluble 0.36; total 8.62; available 8.26; nitrogen 1.68; potash 2.19; availability of nitrogen 89; chlorine 3.

Remark: Source of potash equivalent to kainit.

6384. *Potato and Vegetable Grower,* Thomas Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 3; insoluble 1.50; total 9.50; available 8; nitrogen 1.65; potash 4; phosphoric acid, ⅓ bone tankage, ⅔ acid phosphate; nitrogen ⅓ from sulphate of ammonia, ⅔ from bone tankage; potash from manure salt. Found: Phosphoric acid, soluble, 3.93; reverted 4.07; insoluble 0.43; total 8.43; available 8; nitrogen 1.89; potash 4.52; availability of nitrogen 92; chlorine 1.6.

6407. *Clinch Phosphate,* Blue Grass Mill & Supply Co., Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 3; insoluble 1; total 11; available 10; potash 2; phosphoric acid from acid phosphate; potash from kainit. Found: Phosphoric acid, soluble 3.94; reverted 5.80; insoluble 0.43; total 10.17; available 9.74; potash 2.48; chlorine 2.7.

6408. *Farmers Profit,* Blue Grass Mill & Supply Co., Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 3; insoluble 1.50; total 9.50; available 8; nitrogen 0.83; potash 5; phosphoric acid ⅙ from tankage; 5-6 from acid phosphate; nitrogen ⅕ from sulphate of ammonia, ⅘ from 4% tankage; potash ½ from muriate of potash, ½ from manure salts. Found: Phosphoric acid, soluble 3.98; reverted 4.71; insoluble 0.52; total 9.21; available 8.69; nitrogen 1.05; potash 8.10; availablity of nitrogen 78; chlorine 1.7.

6409. *Standard Phosphate,* Blue Grass Mill & Supply Co., Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble, 5; reverted 3; insoluble 1.50; total 9.50; available 8; nitrogen 2.47; potash 3. Phosphoric acid ⅕ from bone tankage, ⅘ from acid phosphate; nitrogen ⅓ from sulphate of ammonia,

⅔ from bone tankage; potash from manure salts. Found: Phosphoric acid, soluble 3.51; reverted 4.85; insoluble 1.35; total 9.71; available 8.36; nitrogen 2.76; potash 3.24; availability of nitrogen 94; chlorine 2.

6411. *Club Brand,* Blue Grass Mill & Supply Co., Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 3; insoluble 1.50; total 9.50; available 8; nitrogen 0.42; potash 2; phosphoric acid ⅕ from tankage, ⅘ from acid phosphate; nitrogen from 4% tankage; potash ½ from kainit, ½ from manure salts. Found: Phosphoric acid, soluble 3.09; reverted 4.67; insoluble 0.33; total 8.09; available 7.73; nitrogen 0.54; potash 2.54; availability of nitrogen 71; chlorine 3.

Remark: Source of potash equivalent to kainit.

6410. *S. C. Rock,* Blue Grass Mill & Supply Co., Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 4; insoluble 1; total 15; available 14; phosphoric acid from phosphate rock. Found: Phosphoric acid, soluble 11.05; revted 4.87; insoluble 0.79; total 16.71; available 15.92.

D. B. MARTIN COMPANY,

Philadelphia, Baltimore, and Montreal, Canada.

6438. *Martin's Pure Bone .and Potash Compound Bull Head,* Washington, Alexander & Cook, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 6; insoluble 10; total 16; available 6; nitrogen 1.65; potash 2.50; phosphoric acid from pure animal bone; nitrogen from pure animal bone; potash from muriate of potash. Found: Phosphoric acid, soluble 1.81; reverted 8; insoluble 4.64; total 14.45; available 9.81; nitrogen 2.99; potash 3.11; availability of nitrogen 92; chlorine 2.3.

Remark: Source of potash equivalent to manure salt.

G. OBER & SONS COMPANY,

Baltimore, Md.

6362. *Ober's Dissolved Bone Phosphate,* R. N. Stewart &

Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 11; reverted 3; insoluble 1; total 15; available 14; phosphoric acid from high grade Florida phosphate. Found: phosphoric acid soluble 11.99; reverted 3.95; insoluble 0.37; total 16.31; available 15.94.

6398. *Ober's Dissolved Bone Phosphate and Potash,* W. A. Streets, Agent, Belington, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2; phosphoric acid from high grade Florida phosphate; potash from sulphate of potash. Found: Phosphoric acid, soluble 8.47; reverted 2.57; insoluble 0.94; total 11.98; available 11.04; potash 2.16; chlorine 1.6.

Remark: Source of potash equivalent to manure salt.

6361. *Ober's Dissolved Bone Phosphate and Potash,* R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble 7.55; reverted 3.16; insoluble 0.73; total 11.44; available 10.71; potash 2.05; chlorine 2.5.

Remark: Source of potash equivalent to kainit.

6399. *Ober's Stag Guano,* W. A. Streets, Agent, Belington, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 4; phosphoric acid from high grade Florida phosphate ⅞, bone tankage and fish ⅛; nitrogen from high grade bone and blood tankage ⅓ to ½, nitrate of soda ⅓ to ½, fish ⅓ to ½; potash from sulphate of potash. Found: Phosphoric acid, soluble 5.63; reverted 2.50; insoluble 0.77; total 8.90; available 8.13; nitrogen 1.23; potash 4.08; availability of nitrogen 91; chlorine 1.8.

Remark: Source of potash equivalent to manure salt.

6404. *Ober's Dissolved Bone Phosphate,* sent in for analysis by J. H. Dutterer, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 11; reverted 3; insoluble 1; total 15; available 14; phosphoric acid from high grade Florida phosphate. Found: Phosphoric acid, soluble 12.52; reverted 2.56; insoluble 1.55; total 16.63; available 15.08.

6422. *Ober's Standard Potash Compound,* R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 2; insoluble 1; total 13; available 12; potash 5. Phosphoric acid from high grade Florida phosphate; potash from muriate of potash. Found: Phosphoric acid, soluble 9.45; reverted 3.54; insoluble 1.21; total 14.20; available 12.99; potash 5.63; chlorine 1.4.

6423. *Ober's High Grade Acid Phosphate,* R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 14.50; reverted 1.50; insoluble 1; total 17; available 16; phosphoric acid from high grade Florida phosphate. Found: phosphoric acid, soluble 13.38; reverted 4.67; insoluble 0.93; total 18.98; available 18.05.

6424. *Ober's Farmers' Mixture,* G. M. Haines, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 2; insoluble 1; total 10; available 9; nitrogen 0.82; potash 2; phosphoric acid from high grade Florida phosphate 8-9, bone tankage and fish 1-9; nitrogen from high grade bone and blood tankage ½ to ¾, fish ½ to ¾; potash from sulphate of potash. Found: Phosphoric acid, soluble 6.11; reverted 4; insoluble 1.26; total 11.37; available 10.11; nitrogen 1.21; potash 2.19; availability of nitrogen 90; chlorine 1.4.

Remark: Source of potash equivalent to muriate.

PIEDMONT MT. AIRY GUANO COMPANY,

Baltimore, Md.

6269. *Piedmont Potato Producer,* G. W. Niswander & Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, insoluble 2; total 7; available 5; nitrogen 2.09; potash 6; phosphoric acid from dissolved bone and phosphate rock; nitrogen ⅓ bone tankage, ⅓ nitrate of soda and ⅓ blood; potash from high grade muriate of potash. Found: Phosphoric acid, soluble, 3.71; reverted 1.53; insoluble 0.35; total 5.59; available 5.24; nitrogen 2; potash 5.12; availability of nitrogen 96; chlorine 1.6.

Remark. Potash low; source of potash equivalent to manure salt.

6280. *Piedmont Potato Producer,* H. C. Madera, Agent, Morgantown, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble 3.99; reverted 2.02; insoluble 0.26; total 6.27; available 6.01; nitrogen 2.50; potash 5.08; availability of nitrogen 88; chlorine 1.5.

Remark: Potash low; Source of potash equivalent to manure salts.

6270. *Piedmont Special Potash Mixture,* G. W. Niswander & Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, insoluble 1; total 11; available 10; potash 5; phosphoric acid from dissolved phosphate rock; potash ½ from muriate of potash, ½ kainit. Found: Phosphoric acid, soluble 9.76; reverted 1.07; insoluble 0.10; total 10.93; available 10.83; potash 4.27; chlorine 1.9.

Remark: Potash low.

6271. *Levering's Excelsior,* G. W. Niswander & Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, insoluble 1; total 9; available 8; nitrogen 0.82; potash 1; phosphoric acid from dissolved phosphate rock and dissolved bone tankage; nitrogen ½ from blood, ½ from bone tankage; potash ½ from muriate of potash, ½ kainit. Found: Phosphoric acid, soluble 6.22; reverted 1.59; insoluble 0.28; total 8.09; available 7.81; nitrogen 0.52; potash 0.97; availability of nitrogen 72, chlorine 4.3.

Remark: Nitrogen low; source of potash equivalent to kainit; chlorine excessive.

6272. *Piedmont Pure Raw Bone Mixture,* G. W. Niswander & Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, insoluble 4; total 12; available 8; nitrogen 1.02; potash 2; phosphoric acid from dissolved bone tankage; nitrogen from bone tankage; potash ½ from kainit and ½ from muriate. Found: Phosphoric acid, soluble 3.70; reverted 4.68; insoluble 1.96; total 10.34; available 8.37; nitrogen 0.97; potash 2.46; availability of nitrogen 88; chlorine 3.1.

Remark: Source of potash equivalent to kainit. Chlorine excessive.

6273. *Pure Raw Bone Meal,* G. W. Niswander & Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, insoluble 3; total 23; available 20; nitrogen 3.70; phosphoric acid from bone; nitrogen from raw bone. Found: Phosphoric acid, total 23.03; nitrogen 4.01; availability of nitrogen 60.

6279. *Piedmont High Grade S. C. Bone,* H. C. Madera, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, insoluble 1; total 15; available 14; phosphoric acid from S. C. Rock. Found: Phosphoric acid, soluble 14.64; reverted 1.51; insoluble 0.12; total 16.27; available 16.15.

6299. *Piedmont Farmers High Grade Bone and Potash,* G. W. Niswander & Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, insoluble 2; total 12; available 10; potash 2; phosphoric acid from S. C. rock; potash from kainit. Found: Phosphoric acid soluble 6.92; reverted 1.83; insoluble 0.36; total 9.10; available 8.74; potash 2.03; chlorine 2.9.

Remark: Phosphoric acid low.

THE PERUVIAN GUANO CORPORATION,

Charleston, S. C.

6433. *Ex. S. S. Belle of Scotland Genuine Peruvian Guano,* R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, insoluble 1.50; total 10; available 8.50; nitrogen 4.11; potash 2; phosphoric acid from bird manure; nitrogen from bird manure; potash from bird manure. Found: Phosphoric acid, soluble 2.12; reverted 7.74; insoluble 1.47; total 11.33; available 9.86; nitrogen 3.69; potash 1.86; availability of nitrogen 96; chlorine 0.6.

Remark: Nitrogen low.

RAMSBURG FERTILIZER COMPANY,

Frederick, Maryland.

6445. *Soluble Alkaline Bone,* Washington, Alexander &

Cook, Agent, Charlestown, W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 22; insoluble 1; total 13; available 12; potash 3; phosphoric acid from Tennessee rock phosphate; potash ½ from manure potash salts, ½ German kainit. Found: Phosphoric acid, soluble 5.42; reverted 9.48; insoluble 1.77; total 16.67; available 14.90; potash 3.20; chlorine 0.9.

RASIN-MONUMENTAL COMPANY,

Baltimore, Md.

6446. *Seawall Special,* G. M. Haines, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; phosphoric acid from high grade Charleston, Florida and Tennessee Phosphate. Found: Phosphoric acid, soluble 8.70; reverted 2.43; insoluble 1.29; total 12.42; available 11.13.

6244. *Rasin's XXX Fertilizer,* W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.65; potash 5; phosphoric acid from high grade Charleston, Tennessee and Florida phosphate; nitrogen ⅕ to ¼ high grade fish, ⅓ to ½ high grade tankage, ⅙ to ⅕ blood, 1-6 to ⅕ high grade sulphate of ammonia; potash ½ to ⅔ high grade muriate of potash, ½ to ⅓ genuine German kainit. Found: Phosphoric acid, soluble 5.85; reverted 2.10; insoluble 1.62; total 9.57; available 7.95; nitrogen 2.42; potash 6.27; availability of nitrogen 85; chlorine 0.2.

6245. *Monumental Potato Manure,* W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; nitrogen 1.65; potash 7; phosphoric acid from high grade Charleston, Tennessee and Florida phosphate; nitrogen ½ to ¾ high grade fish, ¼ to ½ high grade tankage; potash 9-10 sulphate of potash, 1-10 muriate of potash. Found: Phosphoric acid, soluble 1.47; reverted 4.35; insoluble 1.09; total 6.91; available

5.82; nitrogen 1.93; potash 7.67; availability of nitrogen 90; chlorine 0.5.

6246. *Special Formula for Corn and Buckwheat,* W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; potash 3; phosphoric acid from high grade Charleston, Florida and Tennessee phosphate; potash ¼ to ½ from genuine German kainit; ½ to ¾ high grade muriate of potash. Found: Phosphoric acid, soluble 3.17; reverted 3.13; insoluble 0.75; total 7.05; available 6.30; potash 3.50; chlorine 0.7.

6247. *Rasin's Wheat Potash Mixture,* W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; potash 5; phosphoric acid from high grade Charleston, Florida and Tennessee phosphate; potash ½ to ⅔ high grade muriate of potash ⅓ to ½ genuine German kainit. Found: Phosphoric acid, soluble 4.72; reverted 4.25; insoluble 1.19; total 10.16; available 8.97; potash 4.80; chlorine 1.6.

6248. *Rasin's Acid Phosphate,* W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2; insoluble 1; total 15; available 14; phosphoric acid from high grade Charleston, Florida and Tennessee phosphate. Found: Phosphoric acid, soluble 11.74; reverted 3.06; insoluble 0.32; total 15.12; available 14.80.

6249. *Pure Raw Bone,* W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, total 21.50; nitrogen 3.71; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 23.69; nitrogen 4.01; availability of nitrogen 76.

6281. *William Penn Crop Grower,* Wheeling Implement Co., Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 1; phosphoric acid from High Grade Charleston, Florida and Tennessee phosphate; nitrogen ⅕ to ¼ high grade tankage, ⅓ to ½ high grade fish, ⅙ to ⅕ blood, ⅙ to ⅕ sulphate of ammonia; potash ½ to ⅔ from high grade muriate of potash and 1/3 to 1/2 from genuine German kainit. Found: Phosphoric acid, soluble 6.77; reverted 2.28; insoluble 2.37; total 11.42; available 9.05; nitrogen 1.01; potash 1.61; availability of nitrogen 74; chlorine 0.3.

6327. *Rasin's Royal Fish, Bone and Potash,* A. P. Russell & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.65; potash 3; phosphoric acid from high grade Charleston, Tennessee and Florida phosphate; nitrogen 1/2 to 3/4 high grade fish, 1/4 to 1/3 high grade tankage, 1/5 to 1/3 animal bone; potash 1/2 to 2/3 high grade muriate, 1/3 to 1/2 genuine German kainit. Found: Phosphoric acid, soluble 5.59; reverted 2.36; insoluble 2.09; total 10.04; available 7.95; nitrogen 1. 63; potash 3. 58; availability of nitrogen 86; chlorine 0.8.

6328. *Rasin's Special Bone and Potash,* A. P. Russell & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 5; phosphoric acid from high grade Charleston, Tennessee and Florida Phosphate; potash 1/2 to 2/3 high grade muriate of potash; 1/3 to 1/2 genuine German kainit. Found: Phosphoric acid, soluble 3.75; reverted 5.97; insoluble 1.33; total 11.05; available 9.72; potash 5. 85; chlorine 1.5.

6353. *Rasin's Vegetable Special,* Washington, Alexander, & Cook, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.65; potash 10; phosphoric acid from high grade Charleston, Florida and Tennesse phosphate; nitrogen 1/4 to 3/4 high grade fish, 1/4 to 1/2 high grade tankage; potash 9-10 high grade sulphate of potash 1-10 from high grade muriate of potash. Found: Phosphoric acid, soluble 6.09; reverted 2.42; insoluble 1.01; total 9.52; available 8.51; nitrogen 2.04; potash 10.09; availability of nitrogen 89; chlorine 0.04.

6354. *Rasin's Special Fish and Potash Mixture,* Washington, Alexander & Cook, Agent, Charles Town .W Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; nitrogen 1.65; potash 3; phosphoric acid from high grade Charleston, Tennessee and Florida phosphate; nitrogen ½ to ¾ high grade fish, ¼ to ⅓ high grade tankage, ⅕ to ⅓ animal bone; potash ½ to ⅔ high grade muriate, ⅓ to ½ genuine German kainit. Found; Phosphoric acid, soluble 6.04; reverted 2.04; insoluble 0.73; total 8.81; available 8.08; nitrogen 1.79; potash 3.21; availability of nitrogen 83; chlorine 1.

6419. *Rasin's Half and Half Mixture,* G. M. Haines, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; potash 3; phosphoric acid from high grade Charleston, Florida and Tennessee phosphate; potash ¼ to ½ genuine German kainit, ½ to ¾ high grade muriate of potash. Found: Phosphoric acid, soluble 3.28; reverted 3.65; insoluble 0.60; total 7.53; available 6.93; potash 3.50; chlorine 1.6.

6420. *Rasin's Empire Guano,* G. M. Haines, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.65; potash 2; phosphoric acid from high grade Charleston, Tennessee and Florida phosphate; nitrogen ⅕ to ¼ high grade fish, ⅓ to ½ high grade tankage, ⅙ to ⅕ blood, ⅙ to ⅕ sulphate of ammonia; potash ½ to ⅔ high grade muriate, ⅓ to ½ genuine German kainit. Found: Phosphoric acid, soluble 4.90; reverted 2.88; insoluble 1.53; total 9.31; available 7.78; nitrogen 1.79; potash 2.07; availability of nitrogen 68; chlorine 1.6.

6322. *Washington, Alexander & Cook's Regular Corn Mixture,* Washington, Alexander & Cook, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 3; phosphoric acid from high grade Charleston, Florida and Tennessee phosphate; potash ½ to ⅔ from high grade muriate of potash, ⅓ to ½ genuine German kainit. Found: Phosphoric acid,soluble 6.93; reverted 3.14; insoluble 1.47; total 11.54; available 10.07; potash 2.90; chlorine 1.6.

6326. *Rasin's Irish Potato Special;* A. P. Russell & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 2; insoluble 1; total 8; available 7; nitrogen

3.29; potash 8; phosphoric acid from high grade Charleston, Florida and Tennessee phosphate; nitrogen ¼ to ½ high grade fish, ¼ to ½ high grade tankage, ¼ to ½ sulphate of ammonia; potash 9-10 from sulphate of potash, 1-10 from muriate of potash. Found: Phosphoric acid, soluble 4.58; reverted 2.34; insoluble 0.91; total 7.83; available 6.92; nitrogen 3.54; potash 7.92; availability of nitrogen 95; chlorine mere trace.

SOUTHERN FERTILIZING COMPANY.

York, Pa., and Baltimore, Md.

6335. *Farmers Mixture,* W. C. Hovemale, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2; phosphoric acid from dissolved phosphate rock; potash ¼ to ¾ from manure salt, ¼ to ¾ kainit. Found: Phosphoric acid, acid, soluble 6.17; reverted 3.95; insoluble 0.88; total 11; available 10.12; potash 2.19; chlorine 4.4.

Remark: Chlorine excessive.

6336. *General Crop Grower,* W. C. Hovemale, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.41; potash 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ grabage tankage, nitrogen ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid soluble 3.71; reverted 4.02; insoluble 1.05; total 8.78; available 7.73; nitrogen 0.49; potash 2.17; availability of nitrogen 65; chlorine 4.9.

Remark: Chlorine excessive.

6337. *Farmers Choice,* W. C. Hovemale, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 2; insoluble 1; total 10; available 9; nitrogen 0.82; potash 2; phosphoric acid from dissolved animal bone and dissolved phosphate rock; nitrogen 1-10 to ¼ garbage tankage, ¾ to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble 5.77; reverted 3.51; insoluble 1.25; total 10.53; available 9.28; nitrogen 0.94; potash 2.09; availability of nitrogen 85; chlorine 4.3.

Remark: Chlorine excessive.

6417. *Special for All Crops,* W. H. Wilson, Agent, Romney, W. Va. Guarantee: According to American Agricultural Chemical Co's. Affidavit: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 6; phosphoric acid from dissolved phosphate rock; potash from muriate. Found: Phosphoric acid, soluble 7.14; reverted 4.02; insoluble 0.82; total 11.98; available 11.16; potash 5.63; chlorine 2.2.

Remark: Potash low; source of potash equivalent to manure salt.

6448. *Dissolved Bone Phosphate,* John Burg, Agent, Keyser, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2; insoluble 1; total 15; available 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 12.54; reverted 3.21; insoluble 0.22; total 15.97; available 15.75.

SMITH AGRICULTURAL CHEMICAL COMPANY,

Columbus, Ohio.

6432. *Ohio Farmers Wheat Maker and Seeding Down,* Chester Hardware Co., Agent, Chester, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 3; insoluble 1; total 9; available 8; potash 2; nitrogen 0.82; phosphoric acid from dissolved phosphate rock and dissolved animal matter; nitrogen from animal tankage; potash from muriate Found: Phosphoric acid, soluble 0.92; reverted 7.57; insoluble 2.07; total 10.56; available 8.49; nitrogen 0.91; potash 2.36; availability of nitrogen 77; chlorine 0.9.

6441. *Ohio Farmers Soluble Phosphate and Potash,* Chester Hardware Co., Agent, Chester, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 3; insoluble 1; total 11; available 10; potash 2; phosphoric acid from dissolved phosphate rock; Potash from muriate. Found: Phosphoric acid, soluble 0.57; reverted 10.57; insoluble 2.23; total 13.37; available 11.14; potash 2.11; chlorine 2.0.

Remark: Source of potash equivalent to manure salt.

6442. *Ohio Farmers Alkaline Phosphate,* Chester Hardware Co., Agent, Chester, W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 4; insoluble 1; total 15; available 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 8.90; reverted 6.45; insoluble 2.23; total 17.58; available 15.35.

D. A. THOMAS AND COMPANY,

Hagerstown, Md.

6323. *Thomas's Bone and Potash Mixture,* J. C. and W. M. Burns, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 1.65; potash 2; phosphoric acid from high grade acid phosphate; nitrogen ¼ from high grade animal tankage, ¾ from high grade garbage tankage; potash from kainit. Found: Phosphoric acid, soluble 7.24; reverted 2.40; insoluble 0.58; total 10.22; available 9.64; nitrogen 1.66; potash 3.18; availability of nitrogen 87; chlorine 2.7.

6324. *Soluble Bone and Potash,* J. C. and W. M. Burns, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2; insoluble 1; total 11; available 10; potash 2; phosphoric acid from acid phosphate; potash from kainit. Found: Phosphoric acid, soluble 8.06; reverted 3.20; insoluble 0.77; total 12.03; available 11.26; potash 2.32; chlorine 2.9.

6349. *Crown Jewel,* J. C. and W. M. Burns, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 2; insoluble 1; total 10; available 9; nitrogen 0.82; potash 3. Phosphoric acid from high grade acid phosphate; nitrogen from high grade garbage tankage; potash from kainit. Found Phosphoric acid, soluble 6.51; reverted 2.99; insoluble 0.54; total nessee phosphate; potash ½ to ⅔ from High Grade Muriate of Potash, ⅓ to ½ from genuine German kainit. Found: Phosphoric acid, soluble 7.78; reverted 2.60; insoluble 1.10; total 11.48; available 10.38; potash 4.62; chlorine 0.8.

Remark: Potash low.

6449. *Allison & Addison's Standard Acid Phosphate,* New River Milling Co., Agent, Hinton, W. Va. Guarantee: Phosphoric acid, soluble 9; reverted 3; insoluble 1; total 13; available 12; phosphoric acid from high grade S. C. Phosphate rock, Found: Phosphoric acid, soluble 1.53; reverted 11.01; insoluble 2.05; total 15.49; available 12.54.

6437. *Allison & Addison's Star Brand Guano,* J. M. Miller & Bro., Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 2; total 10; available 8; nitrogen 1.65; potash 1; phosphoric acid from high grade S. C. phosphate; nitrogen ½ from high grade animal tankage and ½ from high grade dry fish; potash ½ kainit, ½ muriate. Found: Phosphoric acid, soluble 5.59; reverted 2.10; insoluble 1..29; total 8.98; available 7.69; nitrogen 2.11; potash 1.79; availability of nitrogen 92; chlorine 3.

Remark: Source of potash equivalent to kainit. Phosphoric acid low.

6414. *Allison & Addison's B. P. Potash Mixture,* J. M. Miller & Bro., Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 3; insoluble 1; total 11; available 10; potash 2. Phosphoric acid from high grade S. C. phosphate rock; potash ½ from kainit, ½ from muriate. Found: Phosphoric acid, soluble 5.52; reverted 4.28; insoluble 1.25; total 11.05; available 9.80; potash 2.08; chlorine 2.2.

Remark: Source of potash equivalent to manure salts.

6421. *Cooper's Special Wheat Grower,* H. C. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; potash 3; phosphoric acid from Charleston, Florida and Tennessee phosphate: potash ½ to ¾ from high grade muriate of potash, ¼ to ½ genuine German kainit. Found: Phosphoric acid, soluble 1.68;

reverted 3.77; insoluble 0.48; total 5.95; available 5.45; potash 3.11; chlorine 1.4.

Remark: Phosphoric acid low.

6412. *S. W. Travers & Co's. Dissolved Bone Phosphate,* J. M. Miller & Bro., Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 11; reverted 3; insoluble 1; total 15; available 14; Phosphoric acid from high grade S. C. phosphate rock. Found: Phosphoric acid, soluble 12.45; reverted 3.38; insoluble 0.68; total 16.51; available 15.83.

THE ROBERT A. WOOLDRIDGE CO.,

No. 8 Light St., Baltimore, Md.

6286. *Old Sledge Phosphate,* Bolby Bros., Agent, Van Voorhis, W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 2; insoluble 1; available 12; potash 5. Phosphoric acid from dissolved phosphate rock; potash 3/5 manure salt, 2/5 muriate of potash. Found: Phosphoric acid, soluble 7.75; reverted 4.36; insoluble 0.82; total 12.93; available 12.11; potash 5.49; chlorine 1.7.

6287. *High Grade Acid Phosphate 16%,* Bolby Bros., Agent, Van Voorhis, W. Va. Guarantee: Phosphoric acid, soluble 13; reverted 3; insoluble 1.50; available 16; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 15.25; reverted 2.50; insoluble 0.33; total 18.07; available 17.75.

6288. *Florida Acid Phosphate,* Bolby Bros., Agent, Van Voorhis, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2; insoluble 1.50; available 14; phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid, soluble 12.13; reverted 3.80; insoluble 0.47; total 16.40; available 15.93.

6289. *Special Potato and Tobacco Fertilizer,* Bolby Bros., Agent, Van Voorhis, W. Va. Guarantee: Phosphoric acid, soluble 7; reverted 2; insoluble 1.50; available 9; nitrogen 1.64; potash 5; phosphoric acid 3/4 from dissolved phosphate rock, 1/4 from bone tankage; nitrogen ⅖ from fish, ⅗ from bone tankage; potash ½ from muriate, ½ from high grade manure salts. Found: Phosphoric acid, soluble 7.71; reverted 2.23; insoluble 1.16; total 11.10; available 9.94; nitrogen 1.80; potash 4.80; availability of nitrogen 88; chlorine 1.1.

6290. *Muriate of Potash,* Bolby Bros. Agent, Van Voorhis, W. Va. Guarantee: Potash 49; potash from muriate of potash. Found: Potash 54.10; chlorine 0.8.

6291. *High Grade Sulphate of Potash,* Bolby Bros., Agent, Van oVorhis, W. Va. Guarantee: Potash 49; potash from fulphate of potash. Found: Potash 51.55; chlorine 0.02.

6431. *Tiger Bone Stock Phosphate,* M. C. Cochran, Agent, Worthington, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 3; insoluble 1.50; total 9.50; available 8; nitrogen 1.03; potash 4.50; phosphoric acid, ¾ from acid phosphate, ¼ from dissolved bone tankage; nitrogen ¾ from animal bone and bone tankage, ¼ from sulphate of ammonia; potash from muriate of potash. Found: Phosphoric acid, soluble 4.27; reverted 4; insoluble 0.51; total 8.78; available 8.27; nitrogen 1.10; potash 5:30; availability of nitrogen 80; chlorine 1.8.

Remark: Source of potash equivalent to manure salt.

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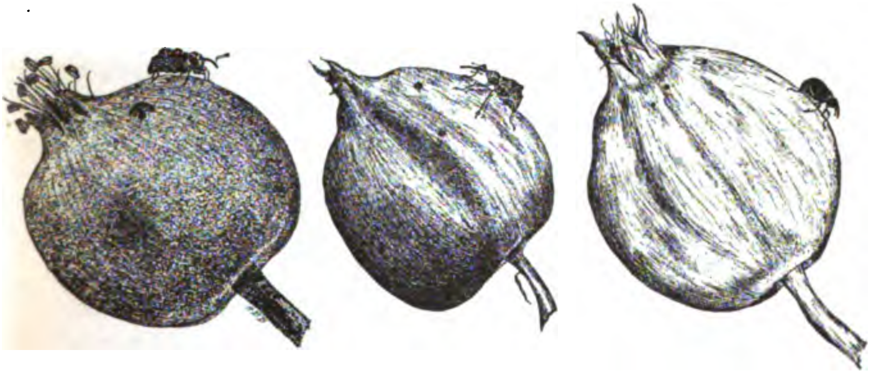
WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 126 JANUARY, 1910

Three Snout Beetles That Attack Apples

Plum Curculio
Apple Curculio
Apple Weevil



BY FRED. E. BROOKS

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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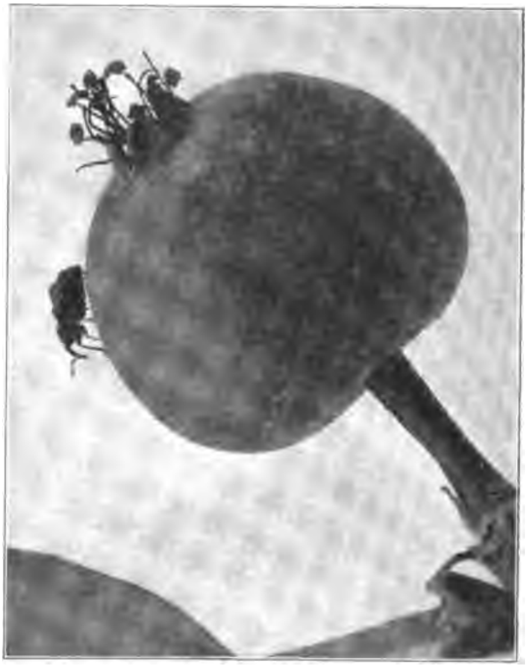

Plum Curculio. Enlarged.

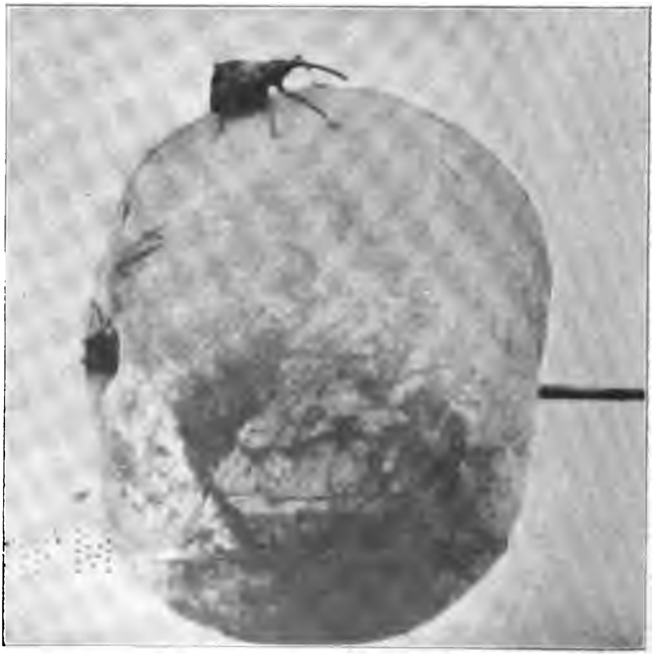

Photo by W. E. RUMSEY

Apple Curculio. Enlarged.

THREE SNOUT BEETLES THAT ATTACK APPLES

FRED. E. BROOKS

INTRODUCTION.

For several years knotty and wormy fruits have composed far too large a proportion of the apple crop in many parts of this State. Where spraying has not been practiced, sound fruits have often been the exception rather than the rule and in many cases almost the entire crop has been next to worthless. This condition has been due largely to the attacks of insects which took place during the growth of the apples on the trees. The insects responsible for most of the worm-holes, scars and other malformations of the fruit are two species of small moths, known as the codling moth and lesser apple worm and three species of snout beetles. The injuries done by these five species are supplemented to some extent by the work of larger caterpillars, wasps and other insects but the bulk of the trouble is due usually to the first-mentioned species.

The codling moth will be considered in another bulletin of this station while this paper will deal with the three snout beetles, two of which are familar under the names "plum curculio" and "apple curculio" and the third, which is not so well known, and which may be called the apple weevil.

It is hoped that this bulletin may aid the fruit grower to a clearer understanding of the habits of these insects and to a better knowledge of the possibilities of holding them in check in the orchard. Such a knowledge should assist in extending the practice of spraying which, at present, is our surest and most practicable method of destroying these pests.

The writer wishes to explain that in describing the habits and life histories of the apple curculio, and, to some extent also, those of the plum curculio, he has drawn freely from the writings of other entomologists.

THE PLUM CURCULIO

(*Conotrachelus nenuphar* Hbst.)

The plum curculio is a snout beetle about one-fifth of an inch long. Its color is a mixture of black, brown and white, with the darker shades greatly predominating. On the back are several prominent humps which give the insect a roughened appearace and make it difficult to distinguish while on the tree from the bark or from a dry bud. It is armed with a curved snout one-third as long as the body.

DISTRIBUTION AND HABITS OF THE BEETLE.

The insect is a native of this country and is distributed over practically all the United States east of the Rocky Mountains. Before orchards were planted within its range it undoubtedly fed and bred on wild plums, crab apples and hawthorns but with the settlement of the country it turned its attention more to cultivated fruits, although it continues to breed on the wild, native varieties. It attacks plums, peaches, nectarines, apricots, cherries, apples, crab apples, pears, quinces and hawthorns and has even been reported as breeding on persimmons. On account of the usual abundance of the insect and the great variety of valuable fruits which it attacks, there is little doubt but that it has been rightfully designated as the most destructive of all the insect enemies of the orchardist in this section of the country.

It injures the fruit by puncturing holes through the skin with its snout both for the purpose of feeding and egg-laying. The feeding punctures may be made in apples at almost any time during the summer but the egg punctures are made mostly while the apples are small. These wounds, and the subsequent

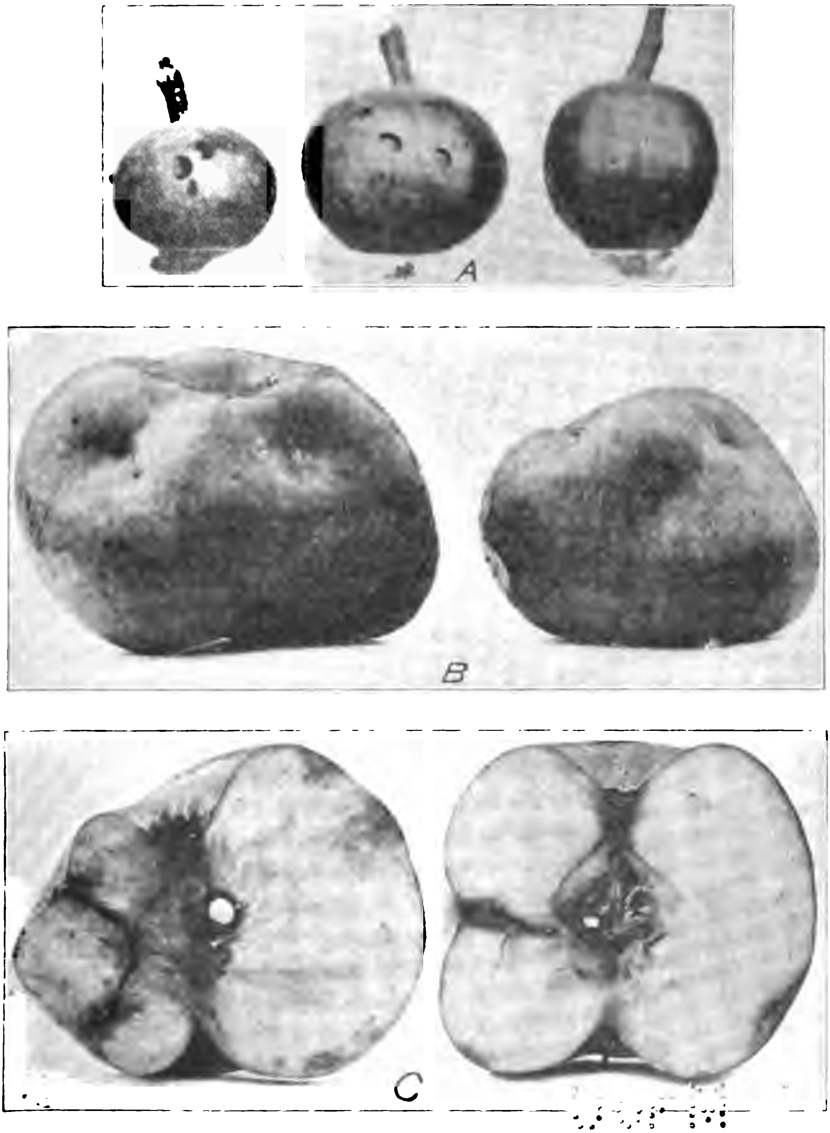

Photo by W. E. RUMSEY

A, two apples on left showing egg punctures of Plum Curculio, one on right showing punctures of Apple Weevil.

B, depressions in surface of mature apples resulting from wounds made by Plum Curculio.

C, sections of apple showing dark lines in flesh where larvae of Plum Curculio have fed.

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feeding of the larvae which hatch from the eggs, cause the fruit to become dwarfed in size, lop-sided, knotty and otherwise misshapen.

INJURIES IN WEST VIRGINIA.

For several years the plum curculio has been very abundant in this State and was notably destructive to apples in the past spring and summer of 1909. By the first of June the apples in many unsprayed orchards showed the marks of the curculio in practically every fruit. Some early ripening varieties, such as Yellow Transparent and Early Harvest, were "stung" until the fruit was scarcely recognizable. On June 23rd the writer counted the egg punctures in the fruit of three young York Imperial apple trees that had not been sprayed. The trees bore 210 apples which contained 1229 "stings," or an average of five to the apple. Only 10 of the fruits had escaped injury. The apples on these three trees did not appear to be injured more seriously than those borne by other trees in the same locality. Many complaints have recently come to the Experiment Station from various parts of the State in regard to injuries to apple by this insect.

LIFE CYCLE.

In the spring, a little before apple trees are in bloom, the beetles leave their hibernating quarters and seek the trees. At this time they feed rather sparingly on the expanding buds and young leaves while at the same time mating is in progress. Plums and cherries are usually the first fruits attacked but when apples are no larger than peas they begin to receive both egg punctures and feeding punctures. Egg-laying goes on rapidly through May and June but after the first of July, as the old beetles die off, oviposition practically ceases. The eggs hatch in four or five days and the small, white larvae, or "worms," when they develop normally, feed on the fruit for from 15 to 20 days and then leave their food and enter the ground. A short distance below the surface the larva hollows out a small cell in the earth in which it transforms to a pupa and later changes to a beetle. The insects remain in the earth for a total period of about a month and then emerge, as beetles, and resort to the trees. During the remaining days of warm weather the young beetles live on the trees and often injure the fruit with their feeding punctures but do not produce eggs the first season. With the approach of cold weather they leave the trees and hibernate. The following spring they emerge from their winter quarters, lay their quota of eggs and after the succeeding generation has been provided for by this means, they die.

DETAILS OF LIFE HISTORY AND HABITS.

The Egg and Oviposition.—The minute egg of the plum curculio is oval in shape and, when first laid, is pearly white but it soon changes to a dingy, yellowish color. It is laid in a little pocket beneath the skin of the fruit which the female fashions with her snout. After the egg is deposited in the pocket the beetle, beginning at the puncture already made through the skin, cuts a crescent-shaped mark partly surrounding the egg. The crescent marks are very conspicuous on smooth-skinned fruits and may be found usually in great abundance by examining bearing apple or plum trees in May or June.

The number of eggs that one female produces has been found by different entomologists to vary greatly, ranging from less than a hundred to 560 in one case. It is a safe estimate that the average individual produces 200 eggs. The eggs hatch in from three to seven days according to temperature.

The Larva.—In stone fruits, such as peach and plum, the larvae feed until full grown and then leave the fruit and enter the ground to a depth of one or two inches where they transform to pupae and a little later to adult insects. In apples, for some reason that does not appear to have been fully explained, the larvae are not able to reach full growth except when the infested fruit drops from the tree or stops growing soon after the larvae begin to feed. When the young curculio undertakes to develop within a vigorously growing apple it may feed for several days, boring its way from the skin toward the core, but it usually dies before the larval stage is half completed.

Many of the wounds made by the beetle are outgrown so that they can scarcely be seen in the ripe fruit. Frequently, however, the burrows made by the larvae show in the mature apples as dark-colored lines of hardened tissue having a bitter taste. On the surface of the fruit the outer ends of these lines are usually marked by scars with sunken, and often rusty areas about them. In the apples that drop the larvae develop normally, and, as many of the infested fruits fall to the ground, there would be an abundance of the beetles produced to perpetuate the species even though there were no host plants but the apple.

The Pupa.—The pupa is a delicate, white object, intermediate between the larva and the beetle, that occupies a cell in the ground, usually within two inches of the surface.

The Beetle.—The beetles mature and continue to emerge from the ground during quite a long period in the summer. After coming out, they are at first somewhat sluggish but they soon begin to feed on foliage and ungathered fruit. In apples they often make cavities of considerable size by repeatedly visiting one feeding place. The injury done to the fruit in this way is quite serious, since such wounds, whether small or large, disfigure the fruit and serve as centers for the spread of decay.

As already stated, the beetles do not lay eggs the first season but remain on the trees until warm weather is about over and then hide away near the ground under rubbish or in grass, or other material that will furnish protection, where they remain until the following spring.

The fact that injury is always worse at points in the orchard near to woods, or to accumulations of trash, indicates that the insects in the fall will go for some distance to seek such places to hibernate, and that they will resort to the most convenient trees when they emerge from hibernation in the spring. The fact also suggests that, where possible, such hiding places should not be allowed to exist in the vicinity of orchards.

NATURAL ENEMIES.

The plum curculio has a number of natural enemies which attack it during the different stages of its existence. In several parts of the country a minute, hymenopterous insect, known scientifically as *Anaphes conotracheli* Girault, has been found to live parasitically within the eggs and to destroy from 16 to 70 per cent of all that are produced. Another four-winged parasite of the curculios, *Sigalphus curculionis* Fitch, is quite common in West Virginia and has been reared repeatedly from the larvae of the plum curculio. The egg of this parasite is deposited in the fruit where the young curculio is feeding and the larva from this egg attacks the immature curculio and destroys it before it transform to a beetle. Ants, of several species, and the larvae of soldier beetles were observed in Upshur County, in 1908, to kill many of the curculio larvae after they had left the fruit and were seeking places to pupate in the ground.

METHODS OF CONTROL.

The injuries done by the plum curculio are not so easily prevented as are those of some other insects, and yet there are a number of methods that can be used against them with a very satisfactory measure of success. In dealing with the insect on apples by far the most effective means of preventing loss is spraying with one of the arsenical poisons, such as Paris green, or, preferably, arsenate of lead. Even where spraying is practiced, however, it is a good plan to use in connection with the operation some of the other measures suggested here, if the best possible results are to be obtained.

Jarring.—This method of dealing with the curculio consists of placing sheets of white cloth under the trees in the early morning and then jarring the insects from the branches to the sheets by striking the body of the tree a sharp blow with a padded mallet. The insects, being thus disturbed, "play possum" and can be collected from the sheets by hand or by shaking them into some receptacle. The sheets may be stretched on light frames of wood so that they can be moved conveniently and rapidly from tree to tree by several persons working together. Another method is to attach the sheets to a hopper-shaped frame mounted on a two-wheeled cart made to push like a wheelbarrow. In making this catcher a slit should be made in the front part of the sheet so that the body of the tree can enter, in pushing the outfit into place. A can of kerosene may be arranged below an opening at the bottom of the hopper so as to catch the curculios that roll down the inclined sides. This method of killing the insects is open to some objection from the fact that a great many lady-bugs and other beneficial species are destroyed along with the curculios.

The jarring of the trees should be begun in the spring soon after the blossoms have disappeared and should be continued every morning for four or five weeks or for as long a time as many beetles are secured. In some experiments conducted by the writer on plum trees, it was found profitable to continue the jarring for five weeks though when practiced every morning for only three weeks decidedly beneficial results were obtained.

This method of destroying the curculios is more practicable for plum and peach trees than for apple trees because of the fact that apple trees are often so large that it is a slow and laborious task to jar them effectively.

Cultivation.—Cultivation of the soil under the trees during July and August breaks up the pupal cells and exposes the young curculios to the light, which is destructive to them, and to the attacks of predacious insects and birds. In this way many of them can be destroyed. In most of the apple orchards of West Virginia the trees are now being headed so low that it is impossible to cultivate directly beneath the branches which is necessary in order to destroy the young curculios by this method. However, the greater ease with which low-headed trees may be sprayed and the other advantages of this form of pruning probably much more than offset this one disadvantage.

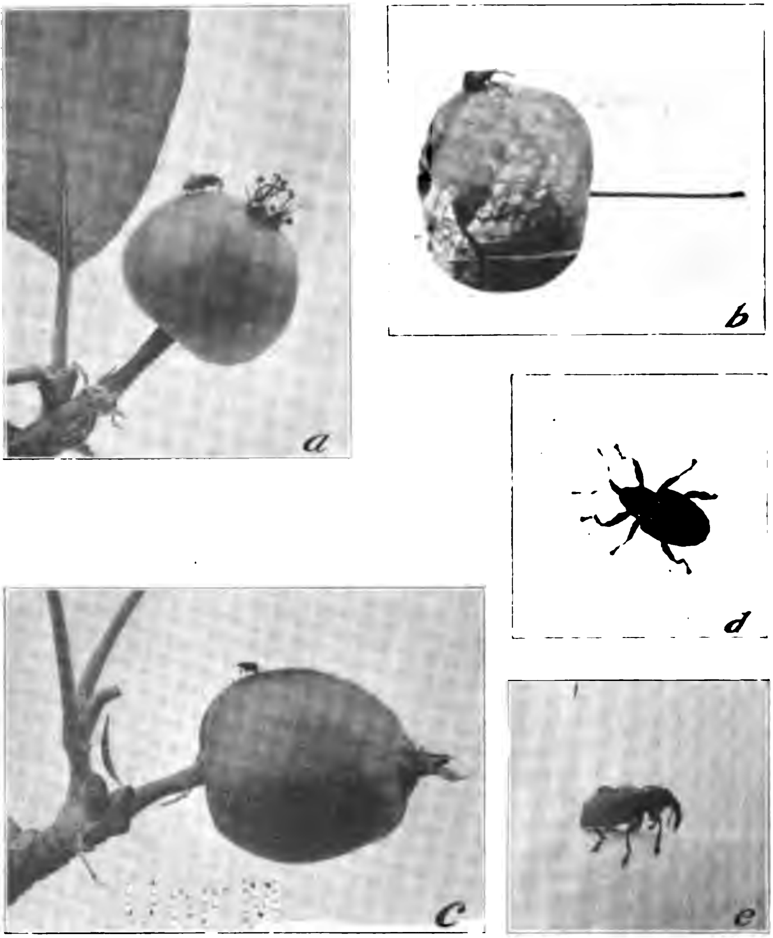
Destroying Fallen Fruit.—If the fruits of any of the varieties in which the curculio breeds are collected from the ground in June and July and burned or fed to hogs many of the insects will be destroyed. Infested fruits usually drop several days before the larvae within them are full grown and by disposing of the drops the number of curculios that would compose the succeeding generation can be greatly curtailed.

Spraying.—The same poisons that are used as sprays on apple trees to destroy the codling moth are the ones most effective against the plum curculio. In dealing with either insect the first spray should be applied as soon after the blossoms have disappeared as possible. The spray should consist of from one to three pounds of arsenate of lead to fifty gallons of water, or, where Bordeaux mixture is used, the same amount of arsenate of lead to fifty gallons of the mixture. This method of dealing with the plum curculio has given good results in many different states and is a well-tried and safe remedy.

In some experiments conducted by this station in Berkeley and Upshur counties, in 1909, it was found that one pound of arsenate of lead to fifty gallons of water, when applied to the trees just after the petals had fallen through a Bordeaux nozzle at a pressure of from 180 to 250 pounds, gave practically the same results against the curculio as the stronger mist sprays when applied oftener at a lower pressure.

By spraying in the two ways mentioned above, Mr. W. E. Rumsey, of the Experiment Station, in an orchard in Berkeley county, reduced the curculio punctures in apples with a single high-pressure spray from 32 per cent to 12.5 per cent and with four mist sprays from 32 per cent to 13.9 per cent.

The writer, after using the two methods of spraying as described above, in an orchard of fifty young York Imperial apple trees in Upshur county, found that on June 23rd, after practically all the curculio eggs had been deposited, 95.4 per cent of the unsprayed apples contained egg punctures, 41 per cent of those treated but once, with the high-pressure spray, contained eggs punctures and 40 per cent of those sprayed four



a, Plum Curculio; b, Apple Curculio; c, Apple Weevil; d, e, Plum Curculios.
a, b and c, natural size; d and e, enlarged.

times with the mist sprays contained egg punctures. This experiment showed an advantage of the sprayed over the unsprayed fruit of about 55 per cent.

A similar saving of the fruit by spraying has been accomplished in many other tests and experiments in this state and in other states.

THE APPLE CURCULIO.

(*Anthonomus quadrigibbus* Say.)

INTRODUCTION.

This insect has been confused often with the plum curculio but in reality it is quite distinct from that species in both appearance and habits. The apple curculio is more reddish-brown in color, the form is more robust and on the back are four prominent humps, the front two of which are much larger than any of the humps on the back of the plum curculio. The snout of the apple curculio is almost as long as the rest of the body, or three times the length of that of the other species. This snout is carried projecting forward, instead of hanging down like an elephant's trunk, as is the case with the plum curculio.

In attacking the fruit the apple curculio bores through the skin, in a manner similar to that of the other species, but after the puncture is completed and the egg laid, only an indistinct speck is left on the surface to mark the place of injury whereas the plum curculio makes the conspicuous crescent-shaped mark. A glance at the insects or at their work is sufficient to enable any one, who is at all well acquainted with the species, to distinguish between the two. The apple curculio is much less abundant and destructive in West Virginia than the other species.

HISTORY AND DISTRIBUTION.

The apple curculio is a native American species of wide distribution. It has been reported from Connecticut and Ontario south to North Carolina and westward as far as New

Mexico. It seems to have been more troublesome in Missouri, Illinois and other mid-western states than elsewhere.

The species was named and described by Thomas Say, in the year 1831. Its life history was worked out in Missouri by C. V. Riley, in 1870, and more thoroughly, by Prof. Charles S. Crandall, of the Illinois Experiment Station, in 1904.

Its original food was the fruit of the thorn and wild crab but as the settlement of the country has provided it with opportunities to attack cultivated apples it has turned its attention from time to time to these fruits and become a pest of considerable importance.

The writer has found this curculio on apple, plum and wild crab at French Creek, Upshur county, and on wild crab at Seebert, Pocahontas county. In both cases on the crab it was present in considerable numbers. While, to our knowledge, it has never been a pest of serious consequence to the apple in West Virginia, yet, the fact that it breeds here, quite probably in considerable numbers in many parts of the state, together with the fact that it seems to be forming a liking for cultivated apples, should lead the fruit grower to regard it with suspicion and to do what he can to prevent its rapid multiplication.

FOOD PLANTS.

The fruits that the apple curculio has been recorded as attacking are the hawthorn, wild crab, haw, wild cherry, quince, pear and apple. Prof. W. E. Britton reports that the beetles, in one case, injured peach trees in Connecticut by puncturing the twigs full of holes.

LIFE HISTORY.

According to Riley and Crandall, the life history of the apple curculio is as follows. The beetles emerge from hibernation early in the spring and soon after the blossoms disappear from the trees, begin laying eggs in the young fruit. Egg-laying extends over a period of about sixty days and one female may produce something over 100 eggs but the average is only about

65 for each individual. The eggs hatch in about five days and the larvae therefrom feed on the flesh of the apple for about twenty days, when they reach full growth and transform to pupae within the fruit. After remaining in the pupa form for about a week they change to beetles and soon after leave the fruit.

Unlike the plum curculio, the young beetles of this species do not appear to injure apples by feeding on them during the late summer and fall after their emergence. According to Crandall, by the first of August most of the beetles have disappeared from the trees and after that date are found near the ground in grass beds and among fallen leaves. Of about twenty-five specimens which the writer bred from crab apples at French Creek more than half the number did not leave the fruit until after August 10th. It appears from this that if the young beetles go to the trees after they emerge from the fruit they may be found on the trees somewhat later in the season here than in Illinois.

APPEARANCE AND HABITS OF THE LARVA.

The larva of the apple curculio is a wrinkled, footless, dingy white grub which, when full grown, is nearly half an inch in length. Some of the body segments in front of the middle are greatly enlarged on the back which gives the larva a hump-backed appearance and prevents it from straightening out as the larva of the plum curculio is able to do. The head is yellowish brown with the jaws dark brown. In feeding it ejects from the fruit a greater quantity of excrement than is thrown out by the larva of the plum curculio. The ejected castings are reddish brown in color and often adhere to the skin of the fruit in conspicuous masses like those seen about the burrows of the codling worm.

HOW THE FRUIT IS INJURED.

Injury is done to the fruit by the beetles which drill pits into the flesh for feeding and for the reception of eggs, and by the larvae which feed and undergo their full development within the fruit.

The feeding punctures made by the beetles extend directly into the fruit to a depth of .08 inch. The egg punctures are similar but are considerably enlarged at the inner end where the egg is located. After the female has deposited her egg in a puncture she seals the opening through the skin with a bit of excrement which becomes hard when dry and probably excludes enemies that would attack the egg.

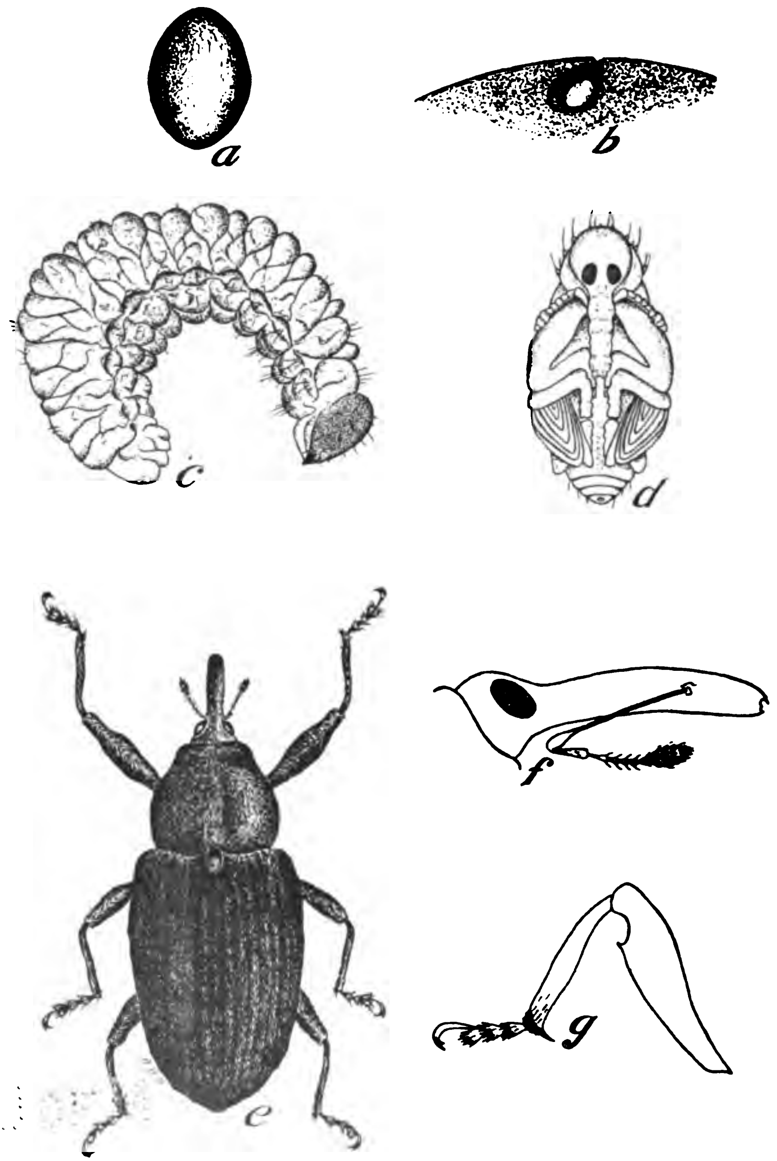
NATURAL ENEMIES.

The writer reared one hymenopterous parasite from wild crab apples infested with larvae of the apple curculio which were collected at French Creek. The adult insect appeared in the breeding jar in which the crab apples were kept on August 18, 1909. Through the kindness of Dr. L. O. Howard, it was determined for me by Mr. H. L. Viereck, of the Bureau of Entomology, as *Pristomeridia agilis* (Cress.)

METHODS OF CONTROL.

Where the apple curculio becomes troublesome care should be taken that no thickets of wild crab or hawthorn are allowed to remain as breeding places near the orchards. Such thickets may produce thousands of the beetles and when the wild fruit becomes insufficient for the great number of beetles they may seek places to feed and oviposit in cultivated orchards.

The jarring method, as recommended for the plum curculio, is effective when used against this species. Spraying with poisons is likely to be beneficial but it is probable that not as many of the beetles will be killed by the opration, as in the case of the plum curculio, for the reason that in feeding they consume little of the exposeed surface to which the poison is applied.



Apple Weevil, *Pseudanthonomus crataegi* Walsh. a, egg; b, location of egg in flesh of apple; c, larva; d, pupa; e, adult; f, snout and antenna; g, leg. All greatly enlarged. Drawings by A. B. Brooks.

THE APPLE WEEVIL.

(*Pseudanthonomus crataegi* Walsh.)

In making observations on the extent of injury that was being done to apples by the plum and apple curculios, during the spring and summer of 1909, it was noticed that another small snout beetle was present on the trees and was doing considerable damage to the young fruit. The insect was not recognized at first and specimens were forwarded to the specialists in Washington who identified them as belonging to the species whose technical name is given above.

The species does not appear to have attracted attention previously as an enemy of apples but according to observations made by the writer the habit of breeding in this fruit seems so well fixed that the common name "apple weevil" is suggested as being suitable.

The first instance that came under our notice, in which apples were attacked by this insect, was in June, 1907, when Mr. W. E. Rumsey, of this department, saw one of the beetles lay its egg in an apple growing on the Experiment Station Farm at Morgantown. In the spring of 1909 Mr. Rumsey also saw numerous punctures in young apples in Berkeley county which he attributed to this species. At French Creek, in Upshur county, the beetles were abundant on apple trees during the past summer, (1909), and in some cases almost every fruit on unsprayed trees showed the punctures of the insect.

HISTORICAL.

Very little has been written in regard to the feeding habits of this insect. It was bred from Cecidomyid galls on crataegus (hawthorn) by Benjamine Walsh, in Illinois, and was described and named by him in 1866. There are a few brief records of the adults having been collected from flowers where they may have been feeding on pollen. LeConte gives its distribution as Middle, Western and Southern States, to Texas. (Rhynchophora of N. A. p. 205.) A. D. Hopkins collected the beetle in Monongalia county, W. Va., in June, 1893.

APPEARANCE AND HABITS OF THE BEETLES.

The apple weevil is a small, elongate beetle, measuring one-tenth of an inch in length, exclusive of the snout, which is a little less than half as long as the body. The snout and prothorax are finely and densely punctured and the wing covers deeply striated. The beetle is a uniform sepia brown throughout with a sparce covering of short yellowish hairs, particularly noticable along the upper part of the prothorax where they form a more or less distinct, longitudinal, dorsal line. This species may be distinguished very readily from either of the curculios described in this paper by its much smaller size, lighter and browner color and the absence of humps on the back.

The beetles emerge from hibernation early in the spring and toward the last of May begin to lay eggs in young apples. On May 28th the writer saw the beetles engaged in oviposition and found the eggs abundant in two varieties of sweet apples and somewhat less abundant in several varieties of more acid fruits in a neglected apple orchard at French Creek. In this orchard egg-laying continued until near the last of June, and soon after that time all the beetles of the over-wintering generation disappeared and oviposition ceased. In addition to observations made in the orchard a number of beetles were kept in breeding jars, as nearly as possible in a natural temperature, and their habits noted. The last egg obtained from the beetles in the jars was laid on June 24th and the last of the beetles died on July 8th.

Early in July the beetles of the second generation began to appear. The first adult of this generation was seen to emerge, with slight assistance, from an infested apple on July 7th, one day before the last of the old generation passed away. By the 25th of July beetles from the early laid eggs were appearing in the breeding jars in considerable numbers though the last individual of them did not leave the apple until August 30th. The period during which the beetles were emerging seemed to be considerably longer than the period of oviposition. This was due to the great variation in the length of time required by the different individuals to complete their transformation. A difference of several weeks, in this respect, was noticed in the individuals which developed from eggs laid by a single female during one day in one apple.

BEHAVIOR OF THE YOUNG BEETLES.

The young beetles after appearing in July and August spend the remaining portion of warm weather about the trees and when cool weather approaches they hibernate, presumably beneath scales of bark and in other sheltered places in and near the orchards. No evidence could be found that these young beetles lay eggs the first season. Twenty-five such beetles were kept in confinement from about the first of August until the first of November. These beetles were supplied with apples at all times but there was no sign of oviposition. A close watch also of the insects on the trees aided in the conclusion that there is but one generation produced annually.

HOW THE BEETLES FEED.

As has been stated already, the beetles feed on the young fruit. This they do by making minute punctures through the skin and then eating all the flesh of the apple that can be reached with the snout through the opening. As the apples increase in size the individuals of both generations feed in the open wounds made by larger insects. They also feed on decayed fruit. A limited portion of their food is obtained from the leaves by scraping fragments of the tissue from the upper surface. The beetles were seen engaged in this manner of feeding on the trees and those kept in confinement riddled the apple leaves with which they were supplied with small holes. From an economic standpoint, this habit of attacking the leaves is important for it brings the species more readily within the reach of arsenical poisons.

OTHER HABITS OF INTEREST.

When the beetles are disturbed by the shaking of the branch on which they are resting or the sudden and near approach of some object that alarms them, they have a habit of raising the front part of the body by extending the forelegs and at the same time elevating the snout so that it points directly forward instead of hanging down. After assuming this pose they will sometimes remain rigid and motionless for several minutes. It usually requires a somewhat violent jar to dislodge them from their position on a branch.

NATURE OF INJURY.

The beetles make two kinds of wounds in the fruit. One of these is made by the female to receive the egg and the other is made by both sexes in feeding. Both forms of wounds are in the shape of minute punctures through the skin which extend to a depth of about .04 of an inch into the flesh of the apple. On the surface of the fruit the average sized opening is slightly less than .01 of an inch across but beneath the skin it is enlarged considerably. Externally the egg punctures may be distinguished from the others by the small mass of glue-like excrement with which the opening through the skin is sealed. The feeding punctures are left open. The wounds are so small that in making a careful examination the aid of a magnifying lens is necessary.

The fruit may be attacked at any point on the surface but the punctures are found usually most numerous about the calyx and stem. So far as could be determined, nearly all the wounds that are made in sound fruit occur when the apples are quite small. The feeding punctures, in cases where decay does not set in, usually heal over so that they show only as minute scars in the ripe fruit. The same is true of the egg punctures where the eggs fail to hatch or where the larvae die soon after beginning to feed, as is often the case. The wounds made by the weevils are sometimes found and enlarged by plum curculios and possibly by other insects that feed on apples. The wounds also form centers for the spread of decay.

The larvae that hatch from the eggs feed on the fruit, forming tortuous tunnels through the flesh, or, more often, make large and irregularly shaped feeding chambers about the core. The excavations are filled with dark-colored, granular excrement scarcely any of which is cast to the surface of the fruit. The larvae are not able to reach full growth within apples that hang to the branch and continue to grow vigorously. They will live for a few days in such fruit, feeding about the chamber in which they hatched, but die after a brief effort to subsist on the juicy, growing fruit. In apples that cease to grow, whether they fall to the ground or remain as mummies hanging to the branches, the larvae live, reach full growth and then pupate within the fruit.

It was not determined whether the wounds of the apple weevil alone are sufficient to cause the apple to drop or whether the species is dependent upon assistance from fungous diseases and other insects in causing the apples to come to a condition which suits their requirements in reaching full development.

THE EGG AND OVIPOSITION.

The egg is yellowish white, oval-oblong in shape, .015 inch wide and .020 inch long. All the eggs observed, with the exception of two, were deposited in punctures excavated from young apples by the female beetle. The two exceptions were cases where the eggs were laid in the stems of apples. After the egg is laid the beetle ejects a small quantity of excrement which is plastered over the opening in the skin, thus effectually sealing the egg chamber. This is evidently done to protect the egg from predacious insects or mites. The time required by the beetle to make the puncture, deposit the egg and seal the hole was observed in one case to be 13 minutes.

Of about a dozen eggs that were laid on June 1st, all hatched on June 5th. In numerous other cases the period of incubation was found to be either four or five days. The exact number of eggs that one individual will produce was not determined. A record was secured, however, from two females that were caught a few days after oviposition was known to be in progress on the trees. The females, each accompanied by a male, were caught on May 29th and the pairs confined separately in glass jars. Fresh apples were placed in the jars each morning and the old ones removed and the eggs counted. One of the females lived until June 25th, a period of 26 days, and laid 119 eggs. The other lived until June 30th, a period of 31 days, and laid 66 eggs. The greatest number laid by one beetle during any one day was 10. Egg-laying by the beetles on the trees seemed to be the most rapid during the period from May 25th to June 15th.

THE LARVA.

The larva is a robust, wrinkled, footless grub about one-eighth of an inch in length. Its color is yellowish white but when feeding on decayed apples the contents of its digestive organs give it a darker appearance. The head is light brown, the jaws dark brown to black. The body is sparsely covered with short hairs, more numerous near the head. From the head the diameter of the body increases gradually to the eighth segment and then decreases more rapidly to the posterior extremity. The larva is always found in a curved or curled-up position and when removed from the apple it moves awkwardly on its side or back and is unable to straighten out and crawl on its belly like the larva of the plum curculio. The larval period was found to vary greatly in length ranging from 18 days, in one case, to 53 days in another. Its average duration seemed to be about 30 days. The larvae are able to subsist on apples that are almost any condition of soundness or decay, except those that are growing vigorously on the tree. Sound, fallen apples, those that are soft and slimy with decay and those that are shriveled and dried until they are almost as hard as wood seem to afford the insect acceptable food. Apparently, the condition of the apple in which the insect was feeding did not effect greatly the duration of the larval stage.

In many cases in the orchard from three to five larvae were found developing in one apple and in the laboratory as many as twenty reached the beetle stage within a single fruit.

THE PUPA.

The larvae change to delicate, white pupae in cells which they make in the tissue of the apple. These cells are just large enough to accommodate the body of the insect and may be located at any place within the apple from near the skin to the core.

The exact length of the pupal stage was observed in only four individuals. In each of the four cases it was 8 days. The development of other individuals that were watched less closely indicated that in some cases the stage may be of longer duration, though the exact time was not noted. It is probable, also, that with some it is less than 8 days. This was indicated in the instance of one precocious individual which accomplished the entire transformation from the laying of the egg to the adult insect in 30 days.

NATURAL ENEMIES.

One parasitic insect was reared from the apple weevil in the manner described as follows. On July 7th an apple was cut open that contained a full-grown weevil larva. Adhering closely to the side of the larva was another minute, white larva that was recognized as a parasite. The two were carefully removed into a breeding bottle and kept under observation. The parasite developed very rapidly in size and two days after being placed in the bottle it had killed and almost entirely devoured its host. When its food was gone it constructed a delicate cocoon of white silk beside the shriveled skin of the insect it had destroyed. Within this cocoon it changed to a pupa on July 13th and on July 20th it emerged from the cocoon as a small, yellowish-brown, four-winged insect. The insect was sent to Washington where it was determined by Mr. H. L. Viereck as *Bracon anthonomi* Ashm., a species that was reared in 1892 from the strawberry weevil, *Anthonomus signatus,* by Dr. F. H. Chittenden, of the U. S. Department of Agriculture.

MEANS OF CONTROL.

Destroying Fallen Fruit.—The weevils usually remain in fallen apples for a week or more after they drop and any method of destroying the young apples that accumulate on the ground early in the season will dispose of many of the insects.

Spraying.—A part of the orchard at French Creek, in which the investigations described in this bulletin were carried on, was sprayed with arsenate of lead to control the codling moth and plum curculio. No apple weevils were found on the sprayed trees and the fruit, which was observed closely, showed no injury from this species. The habit which the beetles have of feeding on apple foliage makes it clear that they are within the reach of poisonous sprays and explains their apparent absence on the sprayed portion of the orchard. There is little doubt that many of the beetles are killed by swallowing the poison that adheres to the leaves of sprayed trees.

Jarring.—The beetles can be caught with sheets in the manner described for dealing with the plum and apple curculios, but, as has been stated already, the jarring of large apple trees is not often practicable.

UNIV. OF MICH
JUN 18 1910

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 127 MARCH, 1910

Spraying for the Codling Moth

Eastern and Western Methods Compared

(A PRELIMINARY REPORT)

ENTOMOLOGICAL DEPARTMENT

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

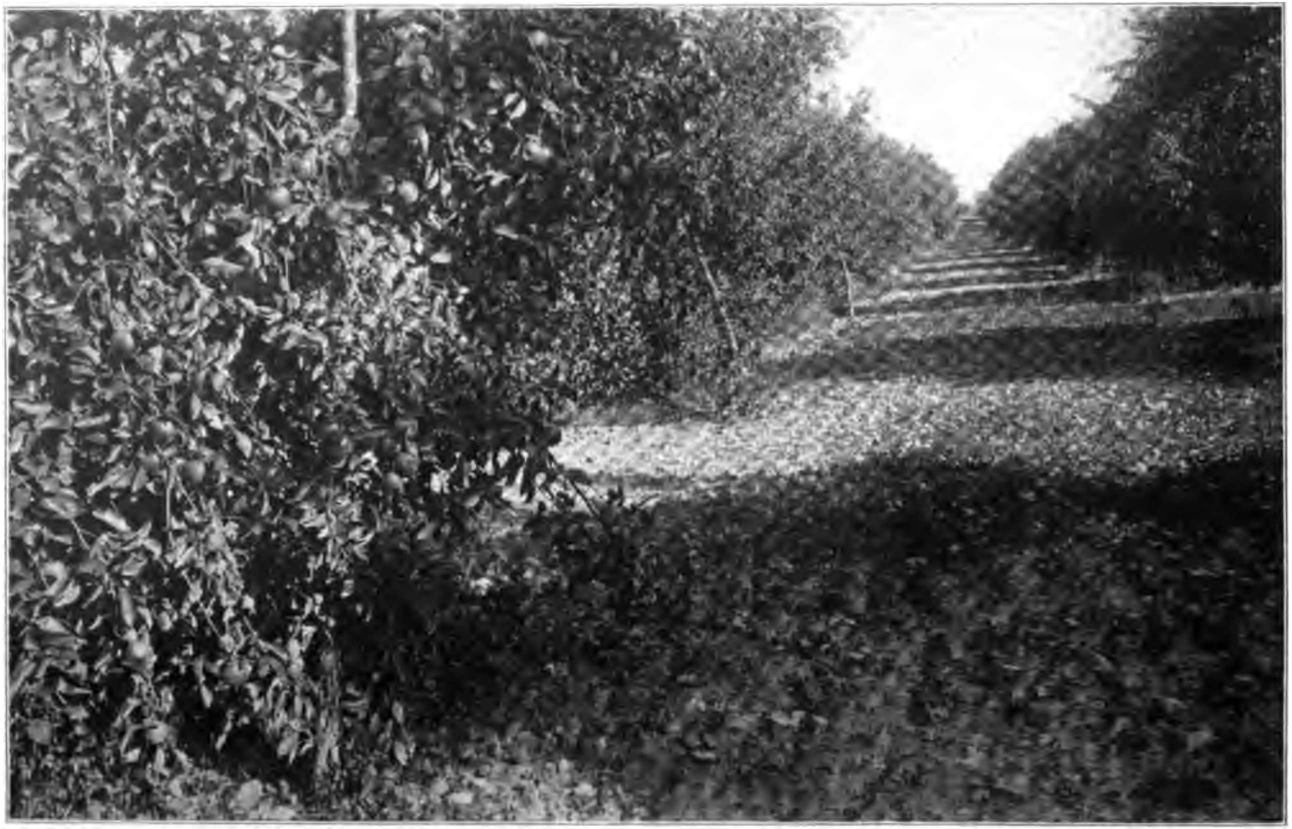


Photo by Fred E. Brooks

Plate I. A view in a properly sprayed orchard. The J. N. Thatcher Company's thirteen year old orchard near Martinsburg, W. Va. Photographs taken a few days before the 1909 crop was harvested.

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Spraying for the Codling Moth

Eastern and Western Methods Compared

(A PRELIMINARY REPORT)

W. E. RUMSEY

INTRODUCTION

Undoubtedly the worst enemy of the apple crop in West Virginia is the codling moth—the insect that causes the wormy apple. This pest is taking altogether too much toll from the apple growers of our State and as our fruit industry is going forward by leaps and bounds more attention must be given to the control of this arch enemy of the orchardist.

A great amount has been written about this insect, and much time and money spent in carrying on experiments to devise ways and means for controling it. At last spraying with arsenical poisons has become the practical method by which this pest is kept in check. However, the manner of applying the poison is not, apparently, definitely settled by the entomologists of the different sections of the United States. When the Eastern entomologists seemed to have hit upon just the way of applying the material—a fine mist spray with a medium amount of pressure applied two or three times during the season, the first spraying just after the petals have fallen—their Western colleagues come forward with the statement, backed up with results obtained in their territory, that a coarse-high-pressure spray applied once at the right time (just after the petals fall) will give as good or even better results than are secured by the application of three or four mist sprays. The reasons advanced for the good results obtained by using the coarse-high-pressure spray is that with this method the poison is forced into the lower calyx cup of the forming apple where it remains ready to be eaten by the young worm when it begins to mine into the apple through the calyx end; while with a mist spray no poison is put into this cavity, merely being left within the surface of the outer calyx cup, and thus not as likely to be eaten by the worm in its passage to the lower cup where it enters the fruit. ''The calyx cups must be filled'' is the slogan of our Western friends if one spraying is to be successful. It is a well known fact that a large majority of the first brood worms enter the apples through the calyx or blossom end; therefore, if these worms are all killed there will not be enough moths develope to lay eggs for the second brood of worms to make it necessary to spray the second time.

Having the Western entomologists firing hot shot into us, at meetings of the American Association of Economic Entomologists, concerning their excellent results in spraying for the codling moth with a coarse-high-pressure spray we decided to make a comparative test of the two methods. While we expect to continue this experiment at least another year or two and then give the public our final results together with a detailed account of the life history and habits of the codling moth for West Virginia we think the findings of last season worthy of a short preliminary report on the subject.

Two spraying tests were carried on during the season of 1909. One in Upshur county, near French Creek by F. E. Brooks on a block of seven year old York Imperial trees, and the other in Berkeley county, near Martinsburg by the writer on a block of sixteen year old Ben Davis trees. The former experiment was on a smaller scale than the latter and the results obtained will appear in our final publication on the codling moth.

THE EXPERIMENT OUTLINED.

On page 129 is a diagram showing the location of the block of Ben Davis trees as regards the balance of the orchard in the

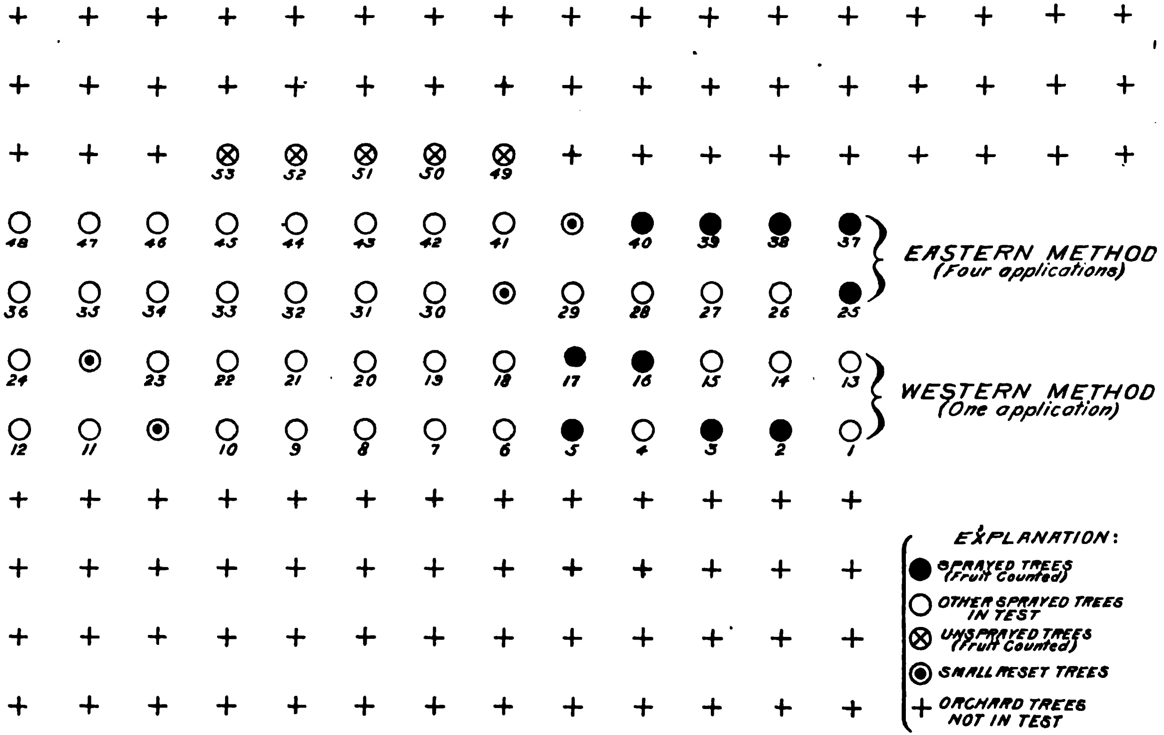

DIAGRAM OF TREES USED IN CODLING MOTH TEST-1909.

Berkeley county experiment. Twenty-four trees were used in the Western method of application and a like number were sprayed according to the Eastern method. Five trees from each of these two plots, as indicated on the diagram, were selected from which to make counts of the fruits for comparing the two methods, also five trees were used as checks that were not to receive any kind of spray during the season to serve as a basis in figuring out the effect of spraying. By an oversight of the workmen check tree No. 49 was sprayed with the mist spray when the first application was made; namely, on May 13th.

By referring to the diagram of the orchard it will be seen that the block of trees selected for the test has other apple trees about it. All those on the side next to the check trees and mist sprayed ones were treated by the owner for the codling moth. The continuation of the orchard on the side adjoining the trees treated according to the Western method is composed of younger trees just coming into bearing, but were not sprayed by the owner for the codling moth as expected. This fact no doubt accounts for many wormy apples by the second brood of worms in the fruit from the trees where the coarse-high-pressure spray was applied.

METHODS OF TREATMENT.

The block of trees designated as "Eastern method" was treated as follows: On May 13th, 1909, just after the petals had fallen, the trees were sprayed with Bordeaux mixture (3-5-50 formula) to which was added three pounds of arenate of lead to each fifty gallons of liquid, using double vermorel nozzles with a pressure of 100 pounds on a gasoline power sprayer. The second spray was applied in like manner and with the same kind of material on May 28th. This was made especially to lessen the injury of the plum curculio. The third spraying was done on June 16th and the fourth and last application was made on July 22nd. The combination of Bordeaux and arsenate of lead is to reach two kinds of trouble with one spraying; namely, the codling moth and curculio on the one hand, and apple scab and similar diseases on the other.

The trees used in the "Western method" of treatment were sprayed on the afternoon of May 12th, 1909 (calyx in the same condition as with the other method) using one pound of arsenate of lead to fifty gallons of water, with a bordeaux nozzle attached to the extension rod at an angle of 45° and the pressure gauge on the gasoline sprayer registering from 200 to 250 pounds. By means of the "crook" on the extension rod the coarse spray, with the high pressure behind it, could be shot directly into the open calyces on all parts of the tree. This was the only spraying of any kind that these trees received during the entire season. No diseases were prevalent in this orchard, hence the apples from these trees where no bordeaux was used were in excellent condition at picking time.

RESULTS ON COUNTED FRUIT.

Beginning on June 23rd all drop fruits from the five trees each of the two methods tested and the five check trees already mentioned, fifteen in all, were examined at intervals during the season up to picking time. Six such observations were made. The number of codling moth apples were noted, care being taken to record those wormy at the calyx, side, and stem. The result of these counts have been arranged in tables (see pages 132, 134, and 136) to show the amount of wormy fruit and to indicate the position where the worms entered the apples from the sprayed and unsprayed trees in the test. Table I (p. 132) shows the total per cent wormy of the drops for the season of the three different groups, which is 2.2 per cent for the coarse-high-pressure treatment; 4.3 for the mist sprayed and 29.6 per cent for the unsprayed trees. Tree No. 49 intended for a check but received one mist spray, as already stated, gives an inkling of what may be expected by the application of one mist spray at the proper

TABLE I

Record of Codling Moth Work—Dropped Fruit for Season.

Western Method of Spraying—Coarse Spray, High Pressure, One Application

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
2	3	13	7	23	755	778	2.95
3	0	11	2	13	287	300	4.33
5	0	7	0	7	686	693	1.01
16	2	5	1	8	502	510	1.56
17	1	10	6	17	746	763	2.22
	6	46	16	68	2976	3044	2.2%

Eastern Method of Spraying—Mist Spray, Medium Pressure, Four Applications

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
25	23	17	1	41	446	487	8.41
37	10	11	4	25	296	321	7.78
38	8	10	1	19	635	654	2.90
39	6	5	1	12	434	446	2.91
40	2	6	0	8	503	511	1.54
	49	49	7	105	2314	2419	4.3%

Check (Unsprayed) Trees—For Comparison

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
50	330	71	11	412	1183	1595	25.83
51	379	63	20	462	1254	1716	26.92
52	311	41	13	365	507	872	41.85
53	165	56	9	230	542	772	29.79
	1185	231	53	1469	3486	4955	29.6%

Tree No. 49. Intended for check, but by mistake mist sprayed May 13

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
49	14	7	0	21	566	587	3.57%

time; the drops in this case showing 3.5 per cent wormy. In these tables of drop apples it is interesting to note the great excess of calyx wormy fruit in the Eastern, or mist sprayed trees over that of the Western, or coarse-high-pressure spraying. The former gives a total of 49 while that of the latter has but 6. The side wormy run about the same—49 for the mist and 46 for the coarse spray. Stem wormy is more pronounced in the coarse-high-pressure treatment—16 to 7. So much for the drops. We will now turn our attention to the tables showing the results at picking time. However, before taking up this matter it might be stated that on July 21st the fifteen trees used for counts were gone over and all the wormy apples that could be found were picked. Therefore, the greater amount of wormy fruit in the harvested crop as shown in table II (page 134) is from the second brood of worms. This table shows a total of 2.8 per cent of picked fruit wormy where the one coarse-high-pressure spray was used and a total of 2.9 per cent wormy where the four mist sprays were applied. The percentage wormy of the unsprayed trees is 38.3. In this case tree No. 49 (mist sprayed once by mistake) shown 12.5 per cent wormy. The proximity of the check trees undoubtedly augmented the wormy fruit on this tree. In the picked apples, as with the drops, the calyx wormy is much more marked in the mist sprayed than in the coarse-high-pressure sprayed trees. The side and stem wormy apples are apparently much greater where the Western method was followed than where the Eastern was used; however, the difference is not so marked when the amount of fruit from the trees receiving the two kinds of spraying is taken into consideration.

Table III (p. 136) represents the total fruit for the season from the fifteen trees and is a combination of the two previous tables.

The average per cent wormy of the total crop where the one-coarse-high-pressure spray was used is 2.6 and that for the mist sprayed trees is 3.3. The checks, or unsprayed trees show an average of 34 per cent wormy. Tree No. 49 show the wormy

TABLE II

Record of Codling Moth Work—Picked Fruit

Western Method of Spraying—Coarse Spray, High Pressure, One Application

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
2	8	103	13	124	2429	2553	4.85
3	0	38	10	48	2328	2376	2.02
5	2	54	6	62	2880	2942	2.10
16	2	34	6	42	1991	2033	2.06
17	3	54	4	61	2050	2111	2.88
	15	283	39	337	11678	12015	2.8%

Eastern Method of Spraying—Mist Spray, Medium Pressure, Four Applications

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
25	9	11	1	21	625	646	3.25
37	18	49	1	68	707	775	8.51
38	5	25	1	31	1626	1657	1.87
39	4	22	5	31	1856	1887	1.64
40	6	30	2	38	1323	1361	2.79
	42	137	10	189	6137	6326	2.9%

Check (Unsprayed) Trees—For Comparison

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
50	304	244	48	596	1352	1948	30.59
51	348	343	45	736	1107	1843	39.93
52	246	150	28	424	485	909	46.63
53	150	89	18	257	290	547	46.98
	1048	826	139	2013	3234	5247	38.3%

Tree No. 49. Intended for check, but by mistake mist sprayed May 13

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
49	19	77	10	106	738	844	12.5%

fruit to have been 8.9 per cent. Expressing these percentages in terms of worm-free fruit we have. Western method, 97.4; Eastern method, 96.7, and the check trees, 65.9.

By comparing the stem wormy apples of the two methods of spraying an interesting point was observed. It will be seen that less worms entered the stem end of the fruit where the four mist sprays were applied than in the case of one coarse-high-pressure spraying. In the growth of the apple it becomes too heavy for the stem to hold it in an upright position as at first and so the fruit topples over, as it were, thus presenting another cup—the stem cup, if you please—into which the material from the late sprays collect and a dose of poison is thus placed in position ready for the larvae of the second brood that may try to enter at this end. While the tables of the unsprayed trees show that but a small per cent of worms enter the fruit at this place the results in the different methods of spraying evidently points to the fact that by filling the stem cup for the second, or later broods where they occur, some good will be accomplished.

In using a coarse nozzle it was found that about twice as much material was applied as in the case of the mist spray; therefore, the amunt of arsenate of lead in the material for the two methods would be in the relation of two to three, although but one pound of the poison to fifty gallons of water was used in the Western method and three pounds in the Eastern. More time was consumed in spraying according to the former method than that of the latter because special care was taken to fill all the calyx cups, but it must also be remembered that only one application was made with the coarse-high-pressure spray while four sprayings were done with the mist spray during the season. Therefore it appears that if the Western method will always give the good results obtained in this test much time would be saved to our Eastern orchardists by using the one-coarse-high-pressure spray already adopted in the far west. With but one or two tests we are not in a position to say which of the two methods herein described will prove of the most value in point

TABLE III

Record of Codling Moth Work—Drops and Picked Fruit Combined

Western Method of Spraying—Coarse Spray, High Pressure, One Application

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
2	11	116	20	147	3184	3331	4.41
3	0	49	12	61	2615	2676	2.27
5	2	61	6	69	3566	3635	1.89
16	4	39	7	50	2493	2543	1.97
17	4	64	10	78	2796	2874	2.71
	21	329	55	405	14654	15059	2.6%

Eastern Method of Spraying—Mist Spray, Medium Pressure, Four Applications

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
25	32	28	2	62	1071	1133	5.46
37	28	60	5	93	1003	1096	8.52
38	13	35	2	50	2261	2311	2.16
39	10	27	6	43	2290	2333	1.84
40	8	36	2	46	1826	1872	2.45
	91	186	17	294	8451	8745	3.3%

Check (Unsprayed) Trees—For Comparison

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
50	634	315	59	1008	2535	3543	28.45
51	727	406	65	1198	2361	3559	33.66
52	557	191	41	789	992	1781	44.30
53	315	145	27	487	832	1319	36.92
	2233	1057	192	3482	6720	10202	34.1%

Tree No. 49. Intended for check, but by mistake mist sprayed May 13

Tree No.	Calyx wormy	Side wormy	Stem wormy	Total wormy	Sound fruit	Total fruit	Per cent wormy
49	33	84	10	127	1304	1431	8.9%

of time and money to the grower. However, in this experiment, the tables before us show that either way has been of much value when compared with the unsprayed trees. In fact, as to final results in this case there is practically no difference between the Eastern and Western methods.

SPRAYING FOR THE PLUM CURCULIO.

The plum curculio ranking next to the codling moth as an apple pest in West Virginia a record was kept of the injury caused by this insect along with that of the codling moth just described. This was done that we might get a better idea of the amount of benefit to be derived by spraying with arsenical poisons to control this pest, and, also to note the relative merits of the Eastern and Western methods in checking it.

Table IV (p. 138) gives the total number of apples from the trees selected for counts of the different methods of spraying and the check trees and are the same as those used in the codling moth test. This table shows 87.4 per cent curculio-free fruit where the Western method was used and 86.1 per cent curculio-free apples with the Eastern method, while the unsprayed trees gave but 67.8 per cent sound fruit. In other words where the one-coarse-high-pressure spray was used 12.5 per cent of the fruit was stung and where the four mist sprays were applied 13.9 per cent of the apples were injured, and the unsprayed trees gave 32.1 per cent of punctured fruit.

In these obervations on the work of the plum curculio it will be seen that the results obtained by the two kinds of spraying do not vary materially from what was secured in the case of the codling moth test, however not as many stung-free fruits were obtained as worm-free ones. This bears out the fact that the plum curculio is a more difficult insect to control than is the codling moth.

TABLE IV

Record of Plum Curculic Work—Drop and Picked Fruit

Western Method of Spraying—Coarse Spray, High Pressure, One Application

Tree No.	No. Fruit Punctured	No. Fruit Sound	Total Fruit	Per cent Punctured
2	513	2818	3331	15.70
3	360	2316	2676	13.41
5	368	3267	3635	10.12
16	294	2249	2543	11.56
17	351	2523	2874	12.21
	1886		15059	12.5%

Eastern Method of Spraying—Mist Spray, Medium Pressure, Four Applications

Tree No.	No. Fruit Punctured	No. Fruit Sound	Total Fruit	Per cent Punctured
25	202	931	1133	17.82
37	237	859	1096	21.62
38	153	2158	2311	6.62
39	281	2052	2333	12.04
40	218	1654	1872	11.64
	1091		8745	13.9%

Check (Unsprayed) Trees—For Comparison

Tree No.	No. Fruit Punctured	No. Fruit Sound	Total Fruit	Per cent Punctured
50	848	2695	3543	23.93
51	1383	2176	3559	38.85
52	521	1260	1781	29.25
53	527	792	1319	39.95
	3279		10202	32.1%

Tree No. 49. Intended for check, but by mistake mist sprayed May 13

Tree No.	No. Fruit Punctured	No. Fruit Sound	Total Fruit	Per cent Punctured
49	121	1310	1431	8.4%

RETURNS FROM PROPER SPRAYING.

In order to better impress upon the minds of our readers the good results that can be secured by thorough spraying, photographs were made of the picked fruit, three of which are reproduced in this bulletin,(plate II opp. p. 140)showing apples from one tree each of the Eastern and Western method of spraying and also that from a check tree. The fruit is arranged in three piles—sound, curculio stung, and wormy—and well illustrates to the eye what may be expected from thorough spraying for the codling moth and plum curculio. Some of the fruit in the wormy piles are also stung by the curulio, but no codling wormy apples occur in the curculio stung piles. Going a little further with our illustration and figuring up the sound apples from the sprayed and unsprayed trees we get a very stiking contrast. Since there is an average of about 360 Ben Davis apples in a barrel, the fruit from the check tree shown in the picture gave about two barrels of sound apples; while four and a half barrels of such fruit was secured from the tree sprayed according to the Eastern method and four and three fourths barrels where the Western method was followed. There were over one and a half barrels of wormy fruit from the unsprayed tree, while only about a peck of such fruit was obtained from either of the sprayed tree.

CONCLUSION.

The results given above between sprayed and unsprayed trees can be obtained by any fruit grower by simply spraying thoroughly with the proper material and at the right time. In order to fully realize the amount of worm-free fruit to be secured by spraying just leave a tree or two without any application and spray the balance thoroughly at the right time. In harvesting the crop carefully observe the wormy apples from the sprayed and unsprayed trees. It will surprise you!

As a "clincher" to the previous statement it might be said that in an orchard of thirteen acres, thirteen years old owned by The J. N. Thatcher Company of Berkeley county, West Virginia, thorough spraying at the right time and with the proper material so reduced the damage from insects and diseases that the owners realized Six Thousand Dollars ($6000.00) from the corp of 1909 above the expenses of picking and packing. Scarcely any wormy apples could be found in this orchard at picking time. The frontispiece of this Bulletin shows a view in the orchard a few days before the crop mentioned was harvested.

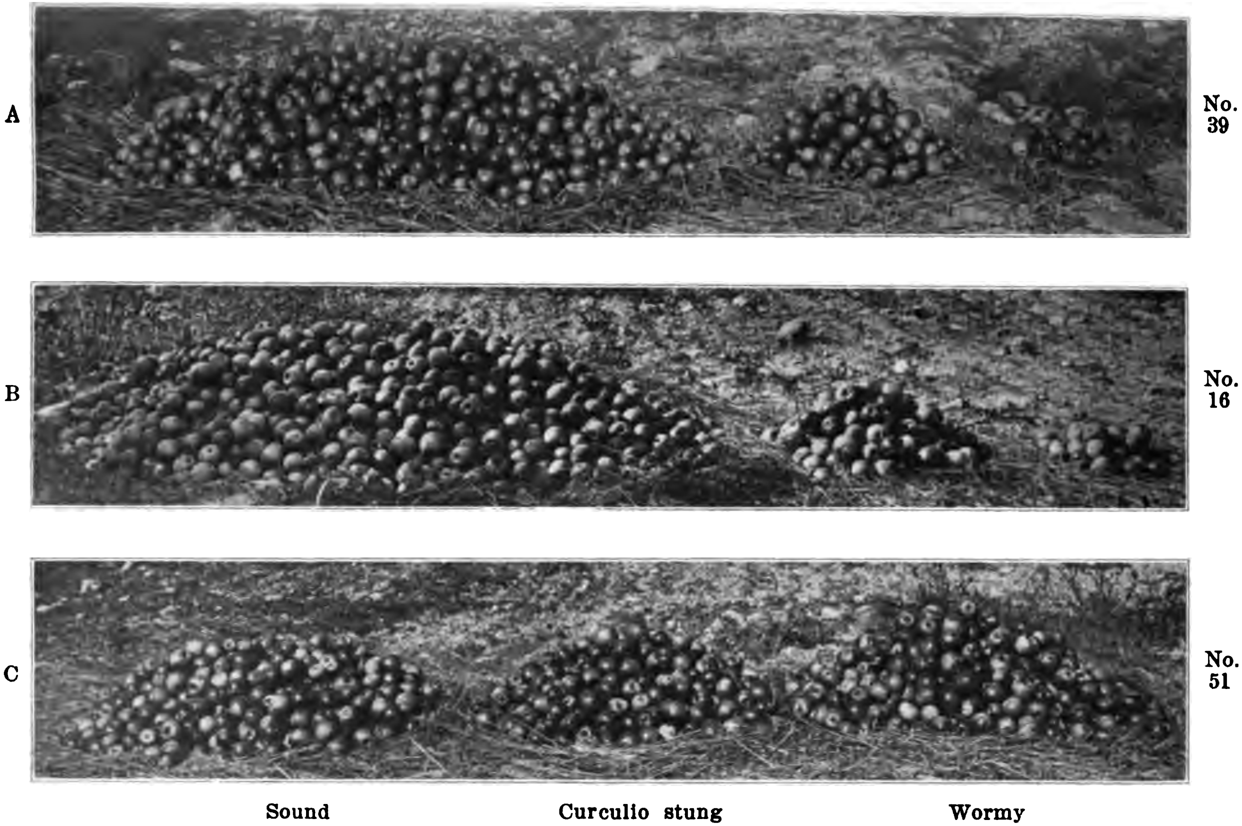

Plate II. Picked fruit from one tree each where the Eastern and Western methods of spraying were applied, also that from an unsprayed tree. *A.* Eastern method—four mist sprays; *B.* Western method—one-coarse-high-pressure application; *C.* Not sprayed.

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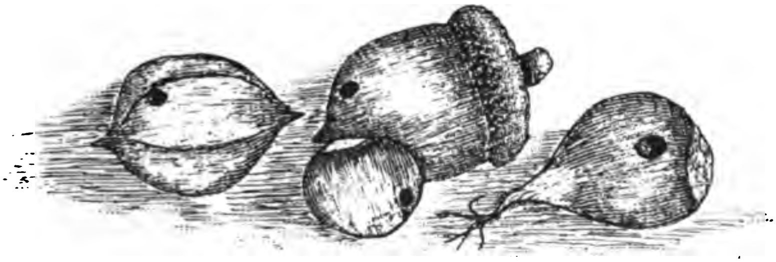
JUN 18 1910

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 128 MARCH, 1910

Snout Beetles That Injure Nuts



By FRED E. BROOKS

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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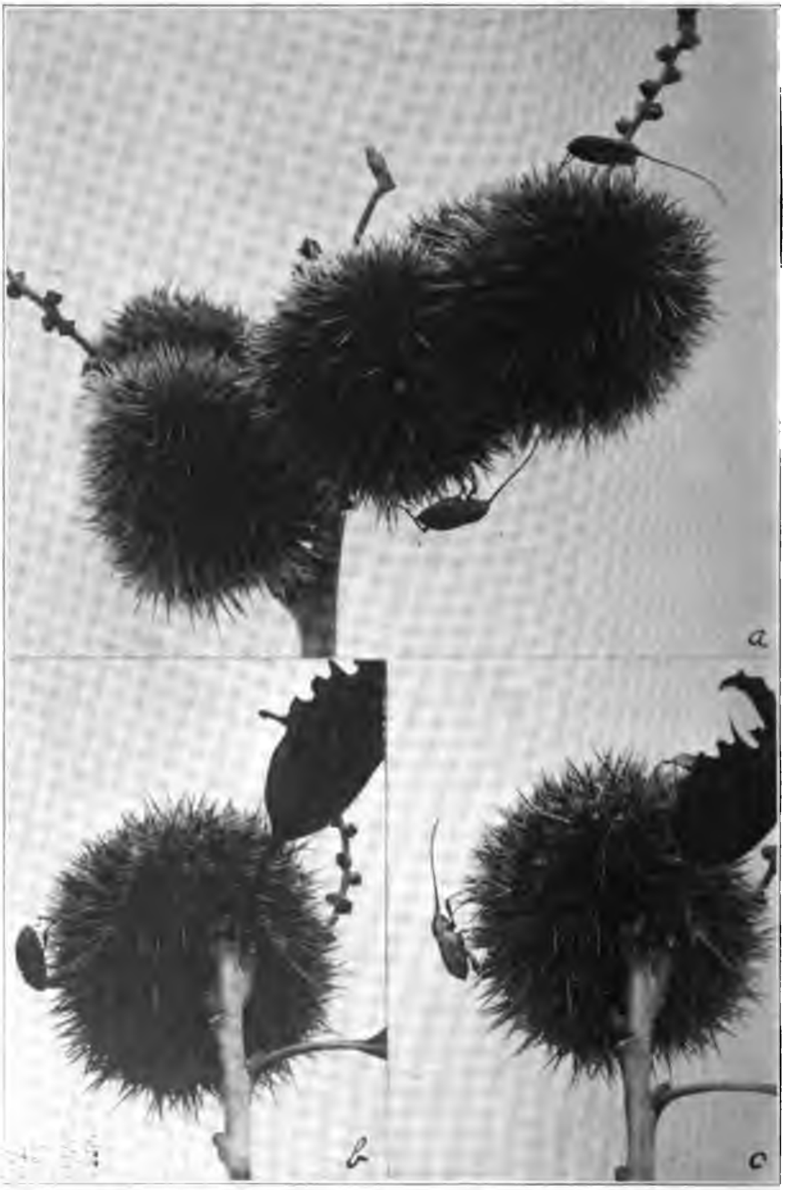


Larger Chestnut Weevil. a and c, female Weevils; b, female boring hole in bur in which to insert an egg. All natural size.

Snout Beetles That Injure Nuts

FRED E. BROOKS

INTRODUCTION

The forests of West Virginia are rich in native nut-bearing trees and shrubs. At least twenty-seven species are found that bear nuts which are used as food by man or by the animals that are of value to man. The nut-bearing trees furnish also the bulk of hard-wood timber that is produced in the State.

With the probable exception of the beechnut, all the more common varieties of nuts, and, presumably, those that are less common as well, are attacked by the larvae, or grubs, of over a dozen different species of snout beetles. Some of these larvae feed on the husks and inner tissues of immature nuts and others on the kernels of nuts that are more nearly ripe. Young walnuts and hickorynuts are frequently attacked soon after the blossoms fall from the trees and the infested nuts drop to the ground before they are half grown. Chestnuts, acorns and some other varieties sustain the greatest injury as they approach maturity. It is not unusual for chestnuts that are kept a week or two after gathering to become from 50 per cent to 75 per cent "wormy" and acorns often suffer to even a greater extent. The infested nuts are rendered unfit for food and in many cases are so badly eaten that they will not germinate when planted.

The injury which these insects do to a valuable article of food and their direct detriment to natural forest development, in causing the failure of many nuts to germinate, make the group an important one from an economic standpoint.

This bulletin is published as a report of an investigation of this class of insects which has extended over a period of several years. Special effort has been made to acquire information regarding the egg-laying habits of the different species, their life histories, seasonal abundance, natural enemies, methods of reducing or preventing loss and to collecting a large number of specimens for systematic study. The work has been carried on in connections with other entomological investigations and the writer is aware that many phases of the study have been passed over too hurriedly to obtain accurate and final conclusions. It is is especially desirable that in the future a more careful study be made of the larvae and pupae of the species considered.

THE NUT INDUSTRY IN WEST VIRGINIA.

The most important feature of the nut industry in West Virginia is the production of native chestnuts. There are several counties that, during favorable seasons, market from 40 to 75 tons each of these nuts. A portion of this crop is gathered from forest trees but most of it probably comes from chestnut groves consisting of second-growth trees that have been allowed to stand in old fields. The nuts bring, in the local markets, an average of about four cents a pound, or $80 a ton, and are a source of considerable income in many localities.

The improved varieties of European and Japanese chestnuts are beginning to be grown in several places in the State and give promise of great success providing they can be kept sufficiently free from insects.

Shellbark hickory trees flourish in many sections and almost every neighborhood has its one or more famous, old hickory trees that are noted locally for the nuts which they bear. Although no great quantity of hickorynuts are marketed, the nuts are, nevertheless, gathered very carefully, often being regaded as too good to sell, and are kept for home and local use. Walnuts, butternuts and hazelnuts are also furnished to the market in a limited way and are gathered in larger quantities for home use.

There is much land in the State that is at present put to little use but which is admirably adapted to the production of various kinds of nuts. As the demand of the market for this commodity increases there is no good reason, apparently, why West Virginia should not undertake to furnish its full share toward supplying the wants of this market.

WHERE AND HOW THE INVESTIGATION WAS CONDUCTED.

Most of the observations herein recorded on the habits of these insects were made at French Creek, W. Va., where many of the important host of the different species abound. In the study of life histories the insects were kept under observation in their natural environment and in breeding jars in the laboratory. The most accurate knowledge of the insects was obtained by observing them in the ground under nut-bearing trees, where they undergo a part of their development, and by ascending into the branches of trees to observe their behavior there

ACKNOWLEDGMENTS.

The writer wishes to acknowledge his indebtedness to Dr. F. H. Chittenden, of the Bureau of Entomology, United States Department of Agriculture, for his courtesy in naming difficult specimens and for offering valuable suggestions regarding methods of studying the group. Thanks are also due Mr. Nathaniel Bacon, Talcott, W. Va., who has plantations of chinquapin and hazel and who took great pains to furnish data and specimens of the weevils that attack the nuts of these plants.

NATIVE NUT-BEARING TREES AND SHRUBS OF WEST VIRGINIA.

According to Millspaugh's "Flora of West Virginia" and to the unpublished notes of A. B. Brooks, Forester for the West Virginia State Geological Survey, the following native, nut-producing trees and shrubs are found within the State. Further study of our species may result in a few additions to this list.

With the probable exception of one or two species, all the nuts in the list are attacked by one or more of the insects under consideration.

Butternut or White Walnut, *Juglans cinerea* L.
Black Walnut, *Juglans nigra* L.
Bitternut or Swamp Hickory, *Hicoria minima* Britt.
Shellbark or Shagbark Hickory, *Hicoria ovata* Britt.
King Nut or Bottom Shellbark Hickory, *Hicoria laciniosa* Sarg.
Mockernut or White-heart Hickory, *Hicoria alba* Britt.
Pignut or Broom Hickory, *Hicoria glabra* Britt.
Little Pignut, *Hicoria glabra* var. *odorata* Sarg.
Hazel, *Corylus Americana* Walt.
Beaked Hazel, *Corylus rostrata* Ait
Beech, *Fagus Americana* Sweet.
Chestnut, *Castanea dentata* Borkh.
Chinquapin, *Castanea pumila* Mill.
Red Oak, *Quercus rubra* L.
Pin or Swamp Spanish Oak. *Quercus plaustris* Muench.
Scarlet Oak, *Quercus coccinea* Muench.
Black or Yellow-bark Oak, *Quercus velutina* Lam.
Bear or Scrub Oak, *Quercus nana* Sarg.
Spanish Oak, *Quercus digitata* Sudw.
Black Jack or Jack Oak, *Quercus Marilandica* Muench.
Shingle or Laurel Oak, *Quercus inbricaria* Michx.
White Oak, *Quercus alba* L.
Post or Iron Oak, *Quercus minor* Sarg.
Burr or Mossy Cup Oak, *Quercus macrocarpa* Michx.
Swamp White Oak, *Quercus platanoides* Sudw.
Chestnut Oak, *Quercus Prinus* L.
Yellow Oak, *Quercus acuminata* Sarg.

"ANNUAL" AND "BIENNIAL" OAKS.

In this paper reference is made repeatedly to "annual" and "biennial" oaks, the distinction being between those in which the acorns ripen in one year and those which require two years to ripen their acorns.

It is scarcely necessary to explain that several of our common oaks blossom in the spring and set acorns that ripen the following fall. Other oaks form acorns at the time of blooming which grow but little until the following spring. They then begin to develop and during the ensuing autumn mature and drop from the trees. The following lists show our species of native oaks belonging to each class.

ANNUAL-FRUITING OAKS. White, Post or Iron, Bur or Mossy-cup, Swamp White, Yellow and Chestnut Oaks.

BIENNIAL-FRUITING OAKS, Red, Swamp Spanish or Pin, Scarlet, Black or Yellow-barked, Spanish, Bear or Scrub, Black Jack or Jack, and Laurel or Shingle Oaks.

CLASSES OF INSECTS THAT INJURE NUTS.

Nuts are attacked by a great variety of insects but the most serious injuries are done by moths and snout beetles. The larvae of several species of moths may be found in chestnuts, beechnuts and acorns, particularly in nuts that have their shells broken so as to permit easy entrance to the kernel by the insects. The damage wrought by the class of insects known as snout beetles, however, is greatly in excess of that done by all other kinds combined.

The term "snout beetle" is applied to the adults of the group of insects which forms the subject of this paper on account of the peculiar structure of the head, the front part of which is prolonged into a snout or proboscis. In some species this snout is short and stout and in others it is long, slender and wire-like. In the females of some of the nut weevils it is longer than the rest of the body. The mouth, which is armed with a minute but strong pair of jaws, is situated on the apex of the snout and the appendage is used for piercing or puncturing various kinds of plant tissue to obtain food and to provide an opening in which to deposit eggs.

The fourteen species of snout beetles which have been found feeding on nuts in West Virginia represents two groups, or genera; ten species belonging to the genus Balaninus and four to the genus Conotrachelus. For convenience, the species of Balaninus are referred to in this publication as "weevils" and those of Conotrachelus as "curculios".

NAMES OF THE INSECTS AND NOTES ON HOST PLANTS.

The following list gives the names of the nut-attacking snout beetles that have been studied in this State together with references to the nuts for which they show a preference. Common names have heretofore been given to but a few of the species and the names used here are merely suggested as possessing some degree of appropriateness. The common names of the first four species in the list have been used in the past but only that of the second has been officially adopted.

Larger Chestnut Weevil, *Balaninus proboscideus* Fab. Chestnuts and chinquapins.

Chestnut Weevil, *B. rectus* Say. Chestnuts and chinquapins.

Hickorynut Weevil, *B. caryae* Horn. Hickorynuts of several species.

Hazelnut Weevil, *B. obtusus* Blanch. Hazelnuts.

Common Acorn Weevil, *B. quercus* Horn. Acorns of red. black, scarlet and other biennial oaks.

Mottled Acorn Weevil, *B. nasicus* Say. Found here most abundant on red oak, more sparingly on other biennials. Has been bred elsewhere from acorns of white and chestnut oaks.

Straight-snouted Acorn Weevil, *B. orthorhynchus* Chittn. Equally abundant on red, black and scarlet oaks.

Sooty Acorn Weevil, *B baculi* Chittn. Common on red, black and scarlet oaks. Less common on white oak.

Confused Acorn Weevil, *B. confusor* Ham. Abundant on chestnut oak. Rare on white oak.

Spotted Acorn Weevil, *B. pardalus* Chittn. Abundant here on white oak and less abundant on chestnut oak. Has been reared in other localities from acorns of biennials and other annuals.

Walnut Curculio, *Conotrachelus juglandis* LeC. Black walnuts and butternuts.

Hickorynut Curculio, *C. affinis* Boh. Hickorynuts.

Larger Acorn Curculio, *C. naso* LeC. Acorns of annual oaks.

Lesser Acorn Curculio, *C. posticatus* Boh. Acorns of annual oaks. Has been bred elsewhere from galls on hickory and from hickorynuts.

TECHNICAL DESCRIPTIONS.

Students who desire technical description of the foregoing species are referred to the following named publications.

B. proboscideus, B. rectus, B. caryae, B. quercus, B. nasicus.

Horn, Geo. H. Proceedings, Am. Phil. Soc., Philadelphia, Vol. 13, p. 458-460.

Hamilton, John, Canadian Entomologist, Vol. 22, pp. 2-8.

B. obtusus.

Blanchard, Frederick, Bul. Brook. Ento. Soc., Vol. 7, p. 107.

Hamilton, John, Canadian Entomologist, Vol. 22, p. 6.

B. orthorhynchus, B. baculi, B. pardalus.

Chittenden, F. H., Proc. Ento. Soc., of Washington, Vol. 10, Nos. 1-2, p. 19-26.

B. confusor.

Hamilton, John, Canadian Entomologist, Vol. 25, pp. 309-310.

C. juglandis, C. affinis, C. naso, C. posticatus.

Le Conte, John L., Proc. Am. Phil. Soc., Vol. 15, pp. 226, 232.

Those desiring to consult works on the biologies of the species are referred to the following publications which are of special value.

Chittenden, F. H., The Nut Weevils, Cir. 99, Bureau of Entomology, U. S. Dept. of Agr., Washington. 1908.

Pierce, W. Dwight, The Biologies of the Rhynchophora of N. A. Ann. Rept. Neb. State Board of Agr., pp. 249-307, 1906-7.

THE NUT WEEVILS.

The nut weevils of the genus Balaninus are elongate beetles that measure, exclusive of the snout, from about one-forth to nearly half an inch in length. The snout is stiff and slender and varies in length from half as long as the body in the males of some species to considerably longer than the body in the females of others. The prevailing color of the upper parts of the body is rich, light brown mottled and spotted with lighter shades. In a few species the color is dark brown to which the lighter-colored, scale-like hairs give a grayish appearance. The under parts of the body are uniformly lighter in color.

The nut weevils are represented in this country by more than twenty described species. About a dozen occur in the eastern part of the United States and of these at least ten are abundant in West Virginia. So far as is known at present, all the members of this genus feed on nuts. Of the species that have been studied in this State, two feed on chestnuts and chinquapins, one on hickorynuts, one on hazelnuts and six on acorns.

The fleshy, cream-colored grubs, or "worms", so abundant in freshly-gathered chestnuts, and less frequently noticed in other nuts, are the larvae of these weevils.

The different species of this group closely resemble one another. In a miscellaneous collection of the beetles, it is a difficult matter to arrange all the specimens specifically. While the beetles are alive, and their habits and movements can be observed on the trees, the resemblances are not so great. If one becomes familiar with the beetles while they are engaged in their occupation of egg-laying he soon discovers peculiarities which enable him to recognize the species on the trees without resorting to close examinations for structural differences.

LIFE CYCLE "IN A NUT SHELL."

The normal life cycle in this locality for all the weevils described in this bulletin is about as follows. Beetles issue from the earth in July and August, several weeks after blossoms have disappeared from nut trees, practically all the individuals of one species leaving the ground at near the same time. Egg-laying continues from the time the meat in the nut begins to form until the nut is full grown. Eggs hatch in from one to two weeks. Larvae feed on kernel of nuts, some species reaching full growth before or near the time the nuts drop and others maturing much later. Full-grown larvae leave the nuts through large, circular holes which they eat in the shell. The larva, after leaving a nut, does not enter other nuts but penetrates the soil for an inch or more where it fashions a small cell, by twisting the body about, in which it passes the winter unchanged. In June, July and August the larvae change to pupae in which stage they remain for two weeks, more or less, and then transform to adults. They remain in their cells as adults for several days, or, often, until a warm rain softens the earth, and then emerge and go to the trees.

Exceptions and Variations.

There are some very decided exceptions to the rule of the life cycle as given above. Occasionally individuals of at least two species will change from larvae to adults, either late in the fall or early in the spring, and issue from the ground in May. I have spent much time in searching in the ground under chestnut, oak and hickory trees in April and May for these early maturing beetles but so far have found examples of only the chestnut weevil and the confused acorn weevil. This act of early transformation seems to occur most frequently with the latter species as I have found, in all, about a dozen specimens in the earth under chestnut oak trees in May. I have also collected the beetles frequently during the same month in jaring plum trees to catch the plum curculio. Their occurrence on the plum trees has probably been accidental as the particular trees from which they have always been collected are growing near an oak woods where the beetles breed in great abundance.

On May 22nd, 1906, I found one female chestnut weevil in the ground under a chestnut tree. This is the only adult of this species that I have taken in the field so early in the season but a little later I have captured several from the blossom catkins of chestnut. This is several weeks in advance of the appearance of the bulk of beetles of this species.

Another departure from the normal life cycle is the case of a small per cent of larvae which remain for two years in their cells in the earth and then transform to beetles and issue from the ground in company with those that develop from the previous season's generation of larvae. This provision is evidently an arrangement of nature to carry the species over a year when a total failure of the nut crop may occur. It is plain that if all the insects of a kind matured during any one year and found no nuts in which to lay their eggs the species would perish from the earth because there would be no means of reproduction. Such a fate does occasionally overtake a large per cent of the individuals of one generation but the few larvae that always remain unchanged in the ground over two winters are able to provide successors the following year. In breeding the insects in the laboratory it has been found that occasionally an individual will remain as a larva until the third summer after it quits the nut. This insures the perpetuation of the species even though all the nut trees should fail for a year or two to bear and furnish food for the insects.

EARLY STAGES OF THE WEEVILS.

The eggs, larvae and pupae of the different species bear a close resemblance to one another. The eggs are small, elongate, translucent white, with a polished surface and fragile shell. There are slight variations in the size and shape of the eggs of the different species but in most cases the distinctions are hardly preceptible. A considerable variation in the shape of the eggs produced by one individual is quite apt to occur.

The larvae differ somewhat in size and in the tints of color but they are all robust, white, creamy-white, or yellowish-white grubs with red or brown heads. The pupae occupy cells in the earth made by the larvae and are usually of lighter color than the larvae. Both stages, in most of the species, need further study before they can be differentiated with any degree of certainty.

BEHAVIOR OF THE ADULT WEEVILS.

The beetles of some of the species of nut weevils may be met with in the field at any time from early in the spring till late in the fall. They are most abundant, however, in July. August and September. Both sexes feed, usually, on the husks or the kernels of the nuts in which they deposit their eggs, but they occasionally depart from this custom and obtain a little food from other parts of the plant. One male larger chestnut weevil was found at French Creek feeding on a Kieffer pear. The food is gotten by boring with the beak into the tissue and swallowing some of the juices and solids that are encountered in making the puncture.

The beak is stiff, and the mouth at the extremity consists in part of a strong pair of jaws. The head, to the front of which the beak is attached, is rounded behind and fits into a concavity in the front of the thorax forming a union like a ball and socket joint. The construction of this joint permits the head to revolve for more than a fourth of its circumference. In piercing a nut the beetle presses the point of the beak against the surface and by rotating the head drills an opening to the desired depth. This organ makes a surprisingly efficient instrument for this work for the insect is able to pierce even the horny shell of the mature pignut which may be a tenth of an inch in thickness and almost as hard as bone. The eggs are placed at the bottom of these galleries made with the snout.

Several writers on the habits of these weevils have believed that after a female has completed her egg-gallery in a nut she deposits an egg at the mouth of the opening and then turns around and pushes the egg into place with her snout. I have watched repeatedly the egg-laying operations of all the weevils mentioned in this bulletin, with the exception of the hazelnut weevil, and have never seen any of the insects use the snout in placing the egg. All the species are provided with long, jointed ovipositors which can be inserted to the full length of any puncture which the snout may make and these ovipositors are used for placing the eggs in the exact spot where they are to remain during incubation. When not in use the ovipositor is telescoped together and withdrawn into the body. It is visible to the observer of the live weevils only for a moment preceeding its insertion into the egg-chamber and then quite frequently only the tip is shown.

The different species have their favorite kinds of nuts to which they adhere with considerable regularity. For example, the two species that feed on chestnuts and chinquapins do not appear to attack any other nuts in the east, although Hamilton records an instance of the chestnut weevil being bred from acorns in Arizona. (Canadian Entomologist, Vol. 22, No. 1.) The hickorynut and hazelnut weevils each infest only its one favorite class of nuts and among those that confine their attacks to acorns there are some species that show a decided preference for certain varieties of acorns. Several species prefer the biennial acorns and are rarely found on the annuals while just the reverse is true of other species. This peculiarity of taste among the acorn weevils is most noticable in a locality where all the species of oaks are bearing at one time. Such a condition permits the beetles to exercise their special preferences to the fullest extent and each species will be found in greatest abundance on the one or more kinds of oak that it likes best. In years when a part of the varieties of oak fail to bear the beetles are less particular and all the different acorn-attacking species have a tendency to collect on the bearing trees,their prejudices of taste being overcome apparently by their desire to feed and oviposit.

In ovipositing the beetles exhibit characteristic differences of procedure which are interesting. Some species deposit their eggs in half-grown nuts while others wait until the nuts are nearly or quite mature. The different species select different points on the nut for making their attacks and some place only one egg in a puncture while others make branched punctures which may contain a dozen eggs. Some are very shy and can scarcely be approached while engaged in egg-laying without becoming frightened from their positions while others are so unsuspicious that they will sometimes allow themselves to be handled with the finger without pausing in their work.

The beetles are slow to fly, preferring to drop to the ground and feign death or to scurry behind some object when disturbed. The operation attending egg-laying is a long and laborious one and when begun late in the afternoon I have seen the female leave her unfinished work at the approach of darkness and seek shelter for the night on the underside of the nut and then resume operations at the same opening on the following morning.

During cool, dark weather the beetles remain in their hiding places resuming activity only on warm days.

THE LARGER CHESTNUT WEEVIL, *Balaninus proboscideus Fab.*

This is the largest of the nut weevils and it is also one of our most abundant and destructive species. It attacks chestnuts and chinquapins, laying most of its eggs early in the season so that at the time the ripe nuts drop from the trees the full grown larvae, or "chestnut worms", as they are commonly called, are abundant in the nuts. I have found a few eggs of this species as late as the 30th of September. The larvae from eggs deposited so late in the season do not leave the nuts until late in the winter.

The beetle is yellow, spotted and mottled with rich, brown shades. The average length of the insect, not including the snout, is nearly half an inch. The snout is long and slender, measuring, in the female, about five-eighths of an inch and in the male about half that length. It is straight at the base with a slight curve at the point. As the insect moves about carrying the huge beak projecting forward it presents a rather grotesque appearance. The character distinguishing this from all other species of the genus is the first joint above the elbow of the antenna which is longer than the second.

In the four years during which I have watched this insect the beetles have always appeared on the chestnut trees early in August, or about two weeks after chestnut blossoms disappear normally from the trees. By the middle of August they are usually abundant and may be found collected about the young chestnut burs. From the middle to the 25th of the month, or, at about the time the tender kernel begins to form in the nut, egg-laying begins and is continued for a period of from five to seven weeks. As the fall advances the beetles gradually decrease in numbers, the last of the generation disappearing late in October, often, not until several severe frosts have occurred. I have found two adults on the trees as early as August 8th and one year collected several from open chestnut burs on October 26th. These are my earliest and latest seasonal records of finding the adults.

The following table shows the dates and progress of the transformation from larvae to adults of over a hundred individuals under perfectly natural conditions. The table shows the state of development in which the insects were found at seven different times during the summer in the soil beneath bearing chestnut trees.

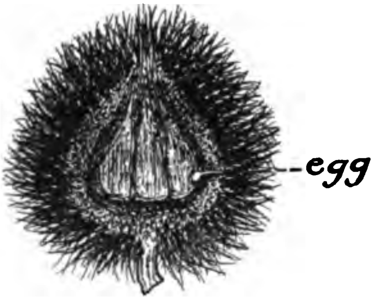
Table Showing Developmeent of Larger Chestnut Weevil.

Date.	Larvae.	Pupae.	Adults.	Remarks.
July 1	18	0	0	(Pupation not begun.)
July 8	10	5	0	(Pupation begun.)
July 26	31	11	8	(Pupae beginning to change to adults.)
Aug. 1	12	0	9	(All pupae changed to adults.)
Aug. 10	29	0	4	(Adults leaving ground.)
Aug. 23	16	0	0	(All adults out of ground.)
Aug. 28	13	0	0	(All adults out of ground.)

The above records were obtained in 1906. There seems to be some variation in the time the insects mature and leave the ground in different years but this variation is not great. The table indicates that the change from larva to pupa begins about

July 8th and that pupation ceases before the last of July. In the year that the observations were made all the beetles had issued by the 23rd of August and for a few weeks thereafter only the biennial larvae occupied the ground. As the new generation of larvae does not begin to leave the nuts and enter the ground until October, the 70 larvae that were found in the ground from August 1st to August 28th must have been hold-over individuals that would not have changed to beetles until another year.

The beetles of this species are comparatively sluggish in their movements and are rarely seen in flight. In ovipositing, the female secures a foothold among the spines of the bur and proceeds to drill a hole which extends directly through all the coverings that envelop the forming kernel. When the kernel is reached she withdraws her snout, turns around and inserts her ovipositor in the opening and passes an egg to the bottom where it reposes in the silken fiber immediately surrounding the kernel. After the egg is deposited the beetle crawls away and pays no further attention to the puncture. One female was observed to spend 56 minutes in the acts attending the deposition of a single egg.



The attack may be made at any point on the surface of the bur but perhaps occurs more frequently near the stem. If the bur is opened after the egg is placed and the nut removed the egg may usually be seen through the opening in the shell. This slight wound in the shell soon heals over, however, and shows only as an obscure scar in the ripe nut.

When the larva is full grown it gnaws a circular hole, one-eighth of an inch in diameter, through the shell and escapes. This species breeds in chinquapins, native chestnuts and in the imported chestnuts which are now being grown in this country.

THE CHESTNUT WEEVIL, *Balaninus rectus* Say.

Chestnuts are frequently gathered that appear sound at first but within ten days or two weeks thereafter become excessively "wormy." Where these "worms" come from has often been a matter of conjecture on the part of those who handle nuts. It is a common belief that they originate from the "sting" of some insect administered at the time the trees are in bloom. As a matter of fact, they hatch from eggs that are in the nuts at the time the nuts are gathered. Most of these eggs are deposited by this chestnut weevil a short time previous to the dropping of the nuts from the trees.

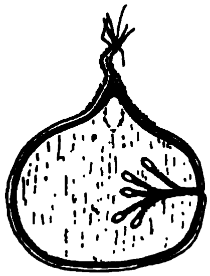
This beetle resembles very closely in a general way the one just described. The shape and color are similar and the beak, like that of the other, is long and conspicuous. It may be distinguished from the larger chestnut weevil by its smaller size, slightly darker color, greater curvature of the snout, and by the first joint of the antenna beyond the scape which is longer than the second. On the tree, this beetle is shyer and more active than the larger species.

The length of the adult insect is from a fourth to a third of an inch. The snout is almost as slender as a horsehair and is curved from the base to the tip. The snout of the female is about four-fifths of an inch long and that of the male about half that length.

As previously stated, beetles of this species may be found occasionally early in the spring. It is not known that these early arriving individuals produce eggs. The bulk of the beetles come from the ground much later in the season; later, by several days, than the larger chestnut weevil. Observations of the insects in the field have shown that in this locality pupation usually takes place between the first and fifteenth of August. In 1906, I found three newly emerged males on the trees on August 28th and on the 30th of the same month two females were found. In 1907, several fresh males and females were found on the trees on August 26th. A few days after the dates given the beetles became very numerous. I have never found the sexes paired on the trees before the middle of September and have not found eggs nor oviposition in progress before September 24th.

In the locality where these observations were made, the earlier chestnut trees begin to open their burs about September 25th and it has been on these trees that I have always found the beetles first engaged in oviposition.

When the four lobes which compose the spiny envelope, or bur, of the chestnut begin to separate, preparatory to turning back to release the ripe nuts, the first effect is a deep groove in the husk along the line where the lobes unite. In grooves of this kind, where the spines are out of the way and where the husk is thin, the beetles collect first to drill their holes into the nuts for the purpose of depositing their eggs. Later, when the burs are open, they get at the kernel, in which their eggs are deposited, by perforating only the brown shell of the nut.



The female, in ovipositing, first pierces the kernel of the nut almost or quite to the center and then turns around and inserts an egg to the bottom of the opening with her ovipositor. This done, she again turns and uses her beak to make a branch gallery within the kernel leading off from the first opening. This branch receives an egg, like the other, and the operation continues until from a single, minute opening in the shell a dozen branches may extend into the nut each containing an egg. In one case I found thirteen eggs in a set but the customary number is from five to eight.

In order to ascertain whether the egg is pushed into place with the beak, as has been claimed often, I removed females several times just after they had laid their first egg and before they had time to reinsert their beak into the opening. In every case I found the egg in its permanent position at the bottom of the gallery showing that after the nut is pierced the ovipositor alone is used in placing the egg.

The egg is similar to that of the larger chestnut weevil except that it is smaller and slightly more elongate. The shape is oval-oblong and the color shining, pellucid white.

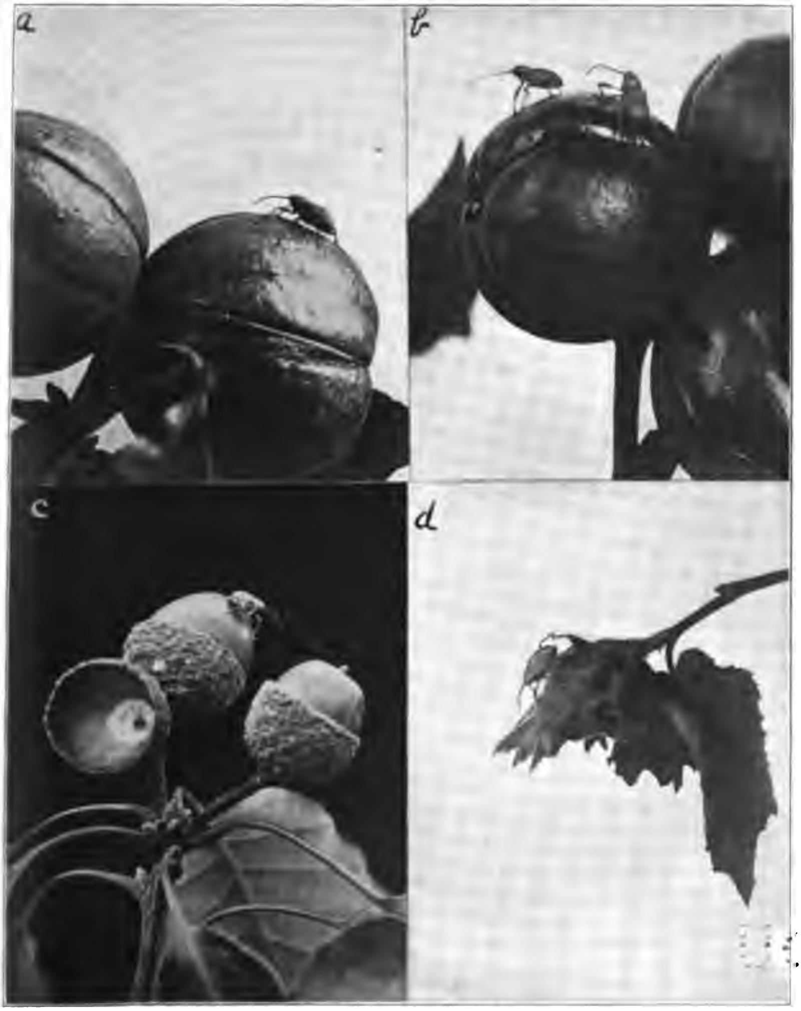
The hole made through the shell in ovipositing and the galleries and eggs within the meat are so small that they are scarcely visible to the naked eye. No foreign flavor is imparted to the nuts by the fresh eggs, and, as their small size prevents their being seen except on close examination, they are often eaten unwittingly by those who go chestnutting in the fall. This is a case where ignorance is bliss, for the punctured chestnuts retain their sweet flavor for a while and no harm comes from the unconscious swallowing of the eggs which the nuts contain.

The larvae remain in the nuts until they have attained full growth and then make their exit through holes which they eat in the shell. The holes made by this species are circular, like those made by the larger weevil, but are smaller, the difference in size being sufficient to enable one to distinguish them from the others. Most of the larvae emerge from the nuts late in the fall but a few remain with their food until mid-winter or even until the warm weather of spring.

THE HICKORYNUT WEEVIL, *Balaninus caryae* Horn.

This enemy of one of our favorite nuts has been known for more than a quarter of a century but it has come into special prominence since the development of the pecan industry in the southern states. In the states farther north the insect attacks shellbark and other varieties of hickorynuts and seems to be more numerous than formerly. Dr. Chittenden has recorded that in some of the southern states the loss to pecan nuts amounted to 75 per cent of the crop in 1903 and 1904. The greatest injury to these nuts has probably occurred in Georgia, Mississippi and Texas.

The shellbark is the only native hickorynut that is used extensively as food in West Virginia, and this variety is seldom more than 20 per cent affected by the weevil. Other varieties, such as the pignut and mockernut, are often destroyed to the extent of from 50 to 75 per cent of the crop. The large, circular holes frequently found in the shells of hickorynuts are made by the larvae of this weevil in escaping.

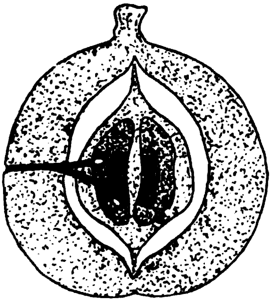


Nut Weevils. a and b, Hickorynut Weevils; c, Confused Acorn Weevil; d, Hazelnut Weevil. All natural size.

The beetle is intermediate in size between the two chestnut weevils. The beak is long and prominent but is a trifle shorter than in either of the species that attack chestnuts. The color of the beetle is dull, dark brown with a grayish tinge in fresh specimens due to a sparce covering of whitish, scale-like hairs. The larva is yellow with a red head and is similar in shape to those of the other species.

The beetles appear on the trees in July, my earliest record being for July 29th, 1908, when eleven were caught on the lower branches of a pignut hickory. On August 8th, 1906, I found the punctures of the weevils quite abundant in the husks of hickorynuts but these punctures were shallow and had evidently been made for feeding as they contained no eggs. My first observation of oviposition was on August 23rd, 1906, when a female was seen to deposit an egg in a nut of the white-heart hickory.

Oviposition has been observed on August 23rd, 25th, 27th, 30th and September 14th and 24th. Evidently, in this locality, most of the eggs are produced from August 25th to September 25th. At the time of oviposition the nuts are approaching maturity, and, as the eggs are placed within the meat of the nut, it is necessary for the beetle to make an opening through the husk and shell for the insertion of the egg. This it does, after the manner of its kind, by drilling a hole with its snout to the desired depth in the nut.



Other nut weevils in depositing their eggs have to contend with the spines of the chestnut bur, the glutinous involucres and hard shells of the hazelnut and the woody cups of acorns but this species has the greatest obstacle of all to overcome in the form of the thick, horny shell of some of its favorite varieties of hickorynut. Its manner of accomplishing the task is interesting and may be explained best by describing the operation as it was observed on September 14th

1909. At a few minutes past noon a female was seen to take a position about half an inch from the point of a nut of the pignut hickory. After turning around several times with the point of the beak moving over the surface of the nut she found a place for making a beginning that seemed to suit her. She then elevated her body by extending her legs to their full capacity and with the point of the beak pressed against the nut began a slight up and down motion at the same time rotating the head. Gradually the point of the beak sank into the husk. As she worked dust-like chips fell although the snout was not removed from the opening. At the end of an hour and 15 minutes the beak was buried to the eyes. When the hole could be made no deeper the beak was withdrawn for the first time and the beetle turned around, the tip of the ovipositor appearing as she turned. In two or three seconds, by an accurate sense of touch, the ovipositor found the spot and was thrust into the orifice. During the deposition of the egg, which occupied a little over a minute, the beetle remained motionless. After the egg was placed she resumed her former position and again inserted the snout into the opening. She immediately began the drilling motion, with the beak about two-thirds buried, and rapidly worked it in to its full length. This was done in forming a branch to the original gallery. In less than thirty minutes the branch was completed and a second egg deposited. The operation was again repeated and after the third egg was deposited the insect crawled away from the nut. The entire operation occupied 2 hours and 14 minutes. The husk of the pignut is thin but the inner shell is thick and almost as hard as bone. This shell was a tenth of an inch in thickness at the point where it was penetrated in the operation just described.

The egg is clear, translucent white, with a shining surface. It is exceedingly delicate in texture and can with difficulty be removed from its place in the nut without breaking. They vary considerably in size and shape. The length ranges from .027 of an inch to nearly .04 of an inch and the width is about .02 of an inch. All are oblong, some being eliptical and others ovate. Irregularly-shaped and lop-sided specimens are frequently found. The time required for the egg to hatch was not ascertained.

I have not found more than three eggs in one nut though that number has been observed several times. Four or five larvae are frequently found in one nut and eight are recorded by Hamilton. It is likely that in some cases more than three eggs are deposited in a puncture but where as many as seven or eight larvae occur they probably represent more than one set of eggs.

The larvae begin to gnaw their way out at about the time the nuts are dropping but many do not escape until mid-winter and many others die within the shell. Several were observed leaving nuts, that had lately been placed in a warm room, on January 6th.

The beetles, when not engaged in feeding or oviposition, have a habit of hiding in dead leaves that are brown and curled and that can be found adhering here and there to the branches. I have examined infested trees on dark days when it seemed that practically every beetle present was hiding in these leaves. Almost every leaf that was in the proper condition contained one or more beetles. I tried hanging bunches of dead leaves to the lower branches and succeeded in trapping many of the insects by that means. Old gunny sacks were tried in the same way but to no purpose for they did not attract the beetles. It is possible that trapping with bunches of dead leaves, or some similar device, might be practiced with benefit in cultivated orchards of pecan and hickory. Other weevils of the group hide in much the same manner but not to the extent of this species.

THE HAZELNUT WEEVIL, *Balaninus obtusus* Blanch.

The hazelnut industry is not large in West Virginia and yet in some sections the nuts are gathered in considerable quantities from the wild bushes and are sold in the local markets or stored for home use. They are very highly prized on account of their rich flavor. Wherever the nuts grow, in this State, they are attacked in varying degrees by the hazelnut weevil. In some cases the injured nuts amount to nearly half the crop and in others not more than 5 per cent are affected. The injury is similar in its nature to that done by the weevils attacking other nuts, the meat of the nut being eaten by the stout, whitish grub which, when full grown, escapes through a round aperture in the shell.

The work of this weevil has been recognized for many years but the species has been confused with others and it was not until recent years that it was found to make the hazelnut its exclusive food. The species was named and described by Frederick Blanchard, in 1884, from specimens secured in Massachusetts and New Hampshire. It has been found as far west as Minnesota and Texas and it probably occurs throughout the eastern states wherever the hazel grows.

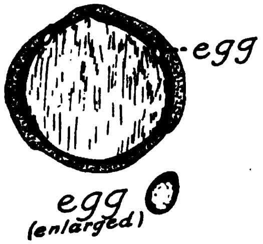
The beetle is similar in color to the two that attack chestnuts but may be distinguished readily from them by its shorter, more robust form and by its very much shorter beak. It is about one-fourth of an inch in length, the beak of the female being half as long as the body and that of the male still shorter.

Most of the information which I have gotten pertaining to the habits of this species has been given to me by Mr. Nathaniel Bacon, of Talcott, W. Va., who has a hazel plantation and who is a careful observer of nature.

The beetles seem to oviposit earlier in the season and to be somewhat shorter lived than the other species. On July 29th, 1908, Mr. Bacon sent me a box of hazelnuts in which there were many larvae and a few eggs of the weevil. Three weeks later,—August 13th,—I visited Mr. Bacon's place and together we made a thorough search for the beetles by examining the bushes and by jarring them over sheets. We spent about half a day in the search and Mr. Bacon continued to look for the insects at intervals for several weeks thereafter but not a beetle was found. At the time I examined the bushes there were many larvae and a few eggs in the nuts but the beetles that had produced them had disappeared. On August 30th the infested nuts were dropping prematurely and the larvae issuing from them. On September 18th, Mr. Bacon wrote that he had just made a careful search for the larvae in two bushels of nuts but that all had eaten their way out and disappeared.

In a lot of 26 "wormy" hazelnuts sent me by Mr. Bacon, 23 larvae had left the nuts on September 14th and only three remained. Eighteen of the exit holes were within one-eighth of an inch of the point of the nut and only two were directly on the side.

Mr. Bacon sent me one beetle which he collected from the bushes on July 23rd. Hamilton, writing of observations made at Allegheny, Pa., states that he did not obtain the beetles by beating hazel bushes previous to June 20th nor after July 15th. Harris records that paired adults have been found on hazelnuts in July. It seems from this evidence that most of the eggs are deposited in July and that the beetles disappear soon thereafter.



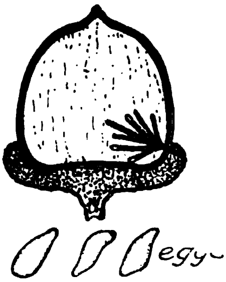
The eggs are eliptical in shape, the surface smooth and shining and the color translucent white. The single egg measured was .04 in. long and .028 in. wide. The act of oviposition was not observed in this species but eggs were found occupying small cavities in the shell, only one egg being found in a place. Feeding punctures were found exending into the kernel but the egg-punctures penetrated only through the shell and the eggs were found within the shell but nearer the inner than the outer surface. In most cases, but not always, the egg-punctures were found about the point of the nut where the shell is accessible without first boring through the involucre.

At the time the larvae hatch the tender kernel is just beginning to form and in several nuts larvae were found that appeared to have been feeding on the delicate fiber that occupies the cavity of the nut previous to the formation of the kernel. The hole made by the beetle in the shell to receive the egg does not entirely heal over and it was observed by Mr. Bacon that the full fed larvae in forming their exit holes enlarge these old wounds, where the shell is defective. After the larvae quit the nut they enter the ground where they remain until the succeeding summer.

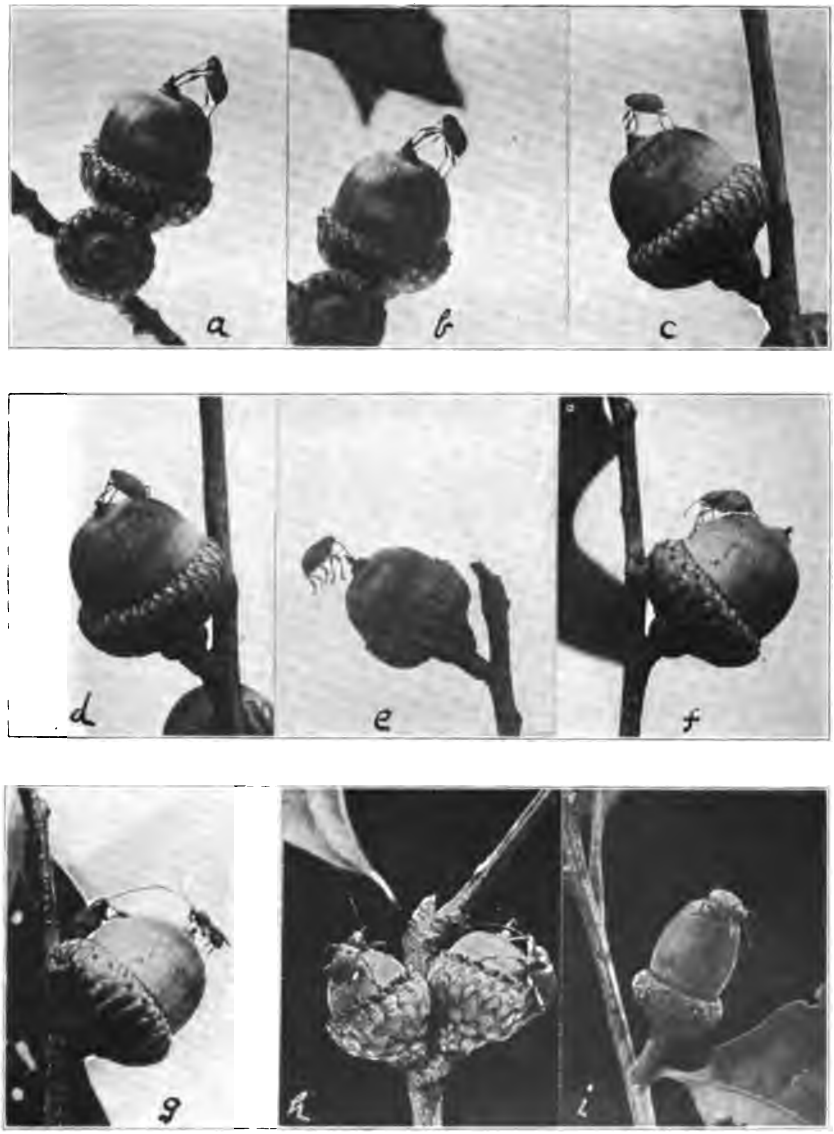
THE COMMON ACORN WEEVIL, *Balaninus quercus* Horn.

This is the largest of the weevils attacking acorns. In size, it is similar to the hickorynut weevil but in color it more nearly resembles the larger chestnut weevil. The spots on the back are smaller than in the latter species, however, and are not so bright and conspicuous. The snout is very slender and is curved at the point. In the female, it is nearly half an inch in length, or, about a fifth longer than the body. In the male, it is about two-thirds as long as the body. The pygidium, or last abdominal segment, of the male is deeply concave with the concavity smooth and shining and surrounded by a rim of silken hairs. This peculiar character enables the species to be separated very readily from all other members of the genus.

This species seems to attack only the acorns of the biennial oaks and in my collecting has always been found more abundant on red oak than on any other tree. The acorns which it attacks are late in maturing and the beetles are correspondingly late in appearing. My earliest record for adults is July 30th, when four newly transformed beetles were found in the ground under a red oak tree. My first specimen from the tree was taken August 23rd. During September and until the middle of October the beetles are abundant on biennial oaks. Egg laying beings about the first of September and continues very active for four or five weeks.



In ovipositing the beetle pierces the acorn to the full length of her long snout and then makes many branches leading off at an acute angle from the first puncture. Eggs are placed at the extremity of only a part of the branches and these are deposited at intervals during the long and tedious task of excavating. After the eggs are all in place the beetle deposits a small mass of ex-



Acorn Weevils. a, b, c and d, Straight-snouted Acorn Weevil preparing a place for its egg; e, Acorn Weevil that has lost its foothold on the nut and hung by the snout until dead; f, Sooty Acorn Weevil; g, Common Acorn Weevil and parasite *Urosigalphus armatus;* h, Common Acorn Weevils; i, Spotted Acorn Weevil. All natural size.

crement over the opening in the shell which is pressed and plastered down with the tip of the abdomen, thus sealing the entrance to the eggs. When the excrement is dry it is of a whitish color and forms a spot on the acorn which is easily seen. So far as I have observed, only one other of the weevils has this habit of sealing the egg-chamber. This is the straight-snouted acorn weevil which is described later.

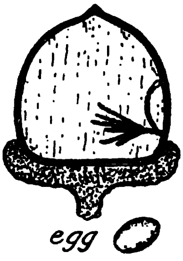
The eggs are translucent white, like those of the other species, and are very irregular in shape. The drawing shows several forms that were produced by one beetle. Two eggs were measured, one being .02 x .03 inch and the other .02 x .04 inch. The larvae of this species devour the entire meat of the acorn, leaving the nuts late in the fall or during the winter through a circular exit hole and enter the ground for hibernation.

THE MOTTLED ACORN WEEVIL, *Balaninus nasicus* Say.

In the localities where I have collected this is the least common of all the acorn-infesting weevils. I have never seen more than two score of the beetles on the trees and these have all been on biennial oaks. Hamilton bred it from acorns of white and chestnut oak and more sparingly from those of scarlet oak. I have found it ovipositing in red oak and, more sparingly, in scarlet and black oak acorns but never in any other variety. The white and chestnut oaks are certainly not preferred in the locality where my observations were made.

The beetle is slightly smaller than in the species last described and the back of fresh specimens is brown, beautifully mottled with clay yellow. The spots are large and have a tendency to form bands across the wing covers. The beak of the female is from one-fourth to three-eighth of an inch in length, or, about the length of the body. The beak of the male is half as long as that of the female.

Hamilton, in Pennsylvania, took the beetles by beating oak branches from about the 10th of May till near October. I have taken them at French Creek from August 8th till September 28th. The beetles are quite likely present in this locality both before and after the dates on which I have recorded them, but, being somewhat scarce, have been overlooked. They are more abundant on the trees, however, in September than at any other time and that is the season when oviposition is most rapid.



In disposition, this beetle is one of the shyest of the group and while engaged in egg-laying is easily frightened from her work. I have watched oviposition on three different occasions. Each time the side of the acorn was attacked. Twice the beetle bored through the edge of the cup into the kernel and the third time she made her entering puncture through the shell only, just beyond the border of the cup.

In preparing thus a place for its egg, the insect first bores a hole directly into the nut which reaches almost to the center of the kernel. It then makes several branches, beginning in the kernel and leading obliquely away from the first opening. This done, it makes another gallery which leaves the original opening just at the point where the kernel and shell meet. This gellery extends into the kernel but curves gradually until it arrives at the inner surface of the shell at a point about one-fifth of an inch from where it began. Into the farthest extremity of this curved gallery the beetle places a single egg and then departs. In one case the side-gallery in which the egg was placed was directed toward the base of the nut so that the egg rested beneath the cup and in the other two cases it extended toward the point of the nut.

The egg is pellucid white and its form may be eliptical, oval or pyriform. In one example the dimensions were;—length, .025 inch, width, .015 inch.

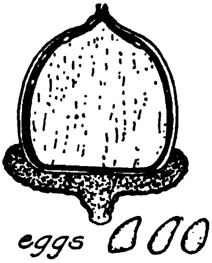
The time required for the egg to hatch was not determined and the larvae was not differentiated from those of the other species with which it associates.

The Straight-Snouted Acorn Weevil, *Balaninus orthorhynchus* Chittn.

This is one of our common species on biennial oaks. I have found it in about equal numbers on red, scarlet and black oaks but have never found it on the annuals. This species has been recorded from West Virginia and Texas only. It was first described in 1908 by Dr. Chittenden.

The color is dull, yellowish brown in fresh specimens and dark, reddish brown where the vestiture is rubbed off. There are usually numerous spots of lighter color on the back but these are very small and indistinct. The female is three-tenths of an inch in length and the snout, which is straight with the exception of a very slight curve near the point, is the same length as the body. The male averages distinctly smaller than the female and the snout is only half as long as the body.

The beetles are found on the trees from about the middle of August until the acorns drop in the fall.



In preparing a place in the acorn for her egg, the female has the peculiar habit of beginning her puncture on the side of the little tip or beak that projects at the apex of the nut. In more than thirty acts of egg laying that I have recorded this rule has not been departed from. The hole is drilled from the side of this beak directly to the kernel and at that point branches and extends between the kernel and shell as deep as the length of the snout will permit. After each branch of the egg-gallery is completed an egg is deposited at the bottom. A female that was watched on September 7th, 1907, spent 45 minutes in preparing a place for and depositing her first egg and then added other eggs at intervals of 21, 14, 9 and 23 minutes, the whole operation lasting for an hour and 52 minutes. Not more than six eggs have been found in one set. After the last egg is inserted the beetle deposits a liberal quantity of excrement over the hole in the shell which hardens in drying and effectually seals the eggs against the attacks of enemies.

It is only with a good deal of difficulty that the beetles are able to get a hole started in the horny texture of which the point of the acorn is composed. In order to effect a beginning they are obliged to extend all their legs to the utmost and even then stand "tip-toe" to get the beak in proper position to use it to advantage. I have found two of the females that, while working in this strained position, had lost their foothold on the nut just after the point of the snout had become buried in the shell, and, not being able to regain their footing, they had hung by their snouts and died.

This species is unsuspicious and the females will allow themselves to be approached closely while egg laying without showing any signs of alarm. I have several times cut off a branch bearing an acorn on which a female was working, and, without disturbing the insect in the least, have carried it five hundred yards and obtained a photograph.

The egg is the same translucent white as in others of the group. It is more elongate than some of the others but varies considerable in size and shape. One measurement gave;—length .035 inch, width .015 inch and another, length .03 inch and width .015 inch. Eggs deposited on September 10th hatched on September 18th or in eight days after being laid.

The larva is white with a pale, reddish brown, sometimes almost white, head. When full grown it escapes from the acorn through a hole in the side and enters the ground.

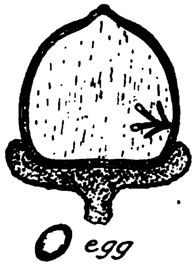
THE SOOTY ACORN WEEVIL, *Balaninus baculi* Chittn.

The dark gray or sooty color of this weevil, with the entire absence of yellow or brown, will serve to distinguish it from all others of the group that are found in this region. Dr. A. D. Hopkins found it on black oak at Kanawha, W. Va. and Chittenden on white oak at Ithaca, N. Y. I have seen it ovipositing in red, scarlet, black and white oak acorns but have always found it most abundant on the biennials.

The species is widely distributed in the eastern states and occurs as far west and south as Nebraska, Indian Territory and Mississippi. It was not differentiated from others, however, until in 1908, when Chittenden described it as a new species.

The beetle is almost black with a dusky gray aspect due to short, whitish hairs which are scattered thinly over the body and which form minute spots on the back. The length averages about a third of an inch and the beak of the female is two-thirds as long as the body, that of the male being half as long as the body.

I have found the newly developed beetles in the soil under red oak trees on August 18th and 19th and have observed the mature insects on the trees from August 28th to October 18th.



The egg-puncture is made through the side of the nut, either through the cup and shell or through the shell alone. The beak being short, the meat of the nut is penetrated only by a shallow wound, and, frequently, when the beetle bores through both cup and shell, the opening extends only to the surface of the kernel. The gallery is made to branch several times and in the ends of from two to four of these branches eggs are placed. The egg is very delicate, transparent white, elongate, pointed at both ends and measures .03 inch long and .025 inch wide. The larva is similar to the others in appearance and behavior.

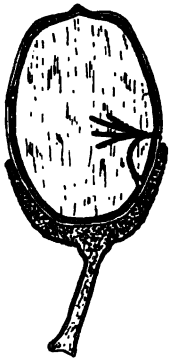
THE CONFUSED ACORN WEEVIL, *Balaninus confusor* Ham.

During the four summers which I have observed this species in an oak woods at French Creek it has always been very abundant on chestnut oak when that variety was bearing. The trees which it frequents are surrounded by four other kinds of oaks but I have found it only once on any of the varieties except chestnut oak. The one case was in 1906 when chestnut oak acorns were very scarce. At that time a few beetles were found ovipositing in white oak acorns.

Hamilton reared it from acorns of bear oak and there is little doubt that further breeding from infested nuts, which is the most accurate method of determining the host plants of any of the species, will show that other kinds of acorns are sometimes attacked. Hamilton records also the remarkable rearing of this species from a gall on a golden-rod.

The beetle resembles the mottled acorn weevil except that the beak is much shorter, it being, in the female, from a fourth to a third shorter than the body and in the male about half as long as the body.

On May 11th, 1906, I found three beetles of this species in the earth under a chestnut oak tree in the woods. A few days later four others were found in a similar situation. I have frequently jarred them from plum trees in May and early in June and have found them on chestnut oak on July 14th. They begin to oviposit in acorns about the middle of August and continue on the trees until the middle of October, the 16th of October being my record for the last adults on the trees.



In boring holes into the acorns for ovipositing, the cup is rarely, if ever, perforated. Most of the punctures are made through the shell just beyond the border of the cup. This is especially true of the punctures for the first eggs of the season. Later, the nut may be attacked near the point. Oviposition is performed by first making a branched gallery that extends into the meat of the nut as far as the beak will reach. After this, several side-galleries are made which extend into the kernel and then curve back to the shell, piercing it for about half its thickness. These lateral branches number from one to five and an egg is placed in the end of each. The point where the egg reposes shows as a slightly discolored spot on the outer surface of the acorn and if the shell be removed the eggs may be found sticking in its inner lining.

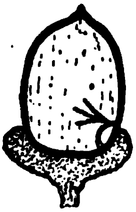
The egg is smooth, creamy white, irregular in size and shape. It averages from .03 to .04 inch long and .02 inch wide.

The larvae often feed in the acorns until late in the winter and convert the meat of the nut into dust so that it will not germinate.

THE SPOTTED ACORN WEEVIL, *Balaninus pardalus* Chittn.

In this locality the beetles of this species show the same preference for acorns of the white oak that those of the last described species show for the acorns of chestnut oak. Frequently I have found this species swarming in white oak trees when not one could be found in nearby oaks of other kinds. Chittenden has reared it from acorns of swamp white oak and black oak.

In a general way, this beetle more nearly resembles the confused acorn weevil than any other species. The size and shape are very similar and the length of the beak is practically the same in both insects. The color of this species is a darker shade of brown and the spots on the back are smaller and more clearly marked. The large mandibles of the male are a distinguishing mark.



The beetles are common on white oak trees from about the first of August until the acorns drop in the autumn.

The operation attending oviposition is very similar to that of the species which attacks the acorns of chestnut oak. The female makes a branched gallery extending toward the center of the acorn and then, through the same opening in the shell, directs a branch to one side in which the egg is placed. So far as has been observed, none of the egg-punctures are made through the cup. The eggs are not distinguishable from those of several other species.

THE NUT CURCULIOS.

The group of snout beetles commonly known as curculios is made notorious by the habit which some of the species have of attacking orchard fruits. Several species of the group attack nuts and some of these resemble very closely that formidable enemy of the fruit grower, the plum curculio. In their life histories and general characteristics the likeness of the different species is still futher borne out.

As compared with the nut weevils, the curculios are smaller and the snout much shorter. The more important species pass the winter in the adult or beetle form and deposit their eggs in young nuts early in the summer.

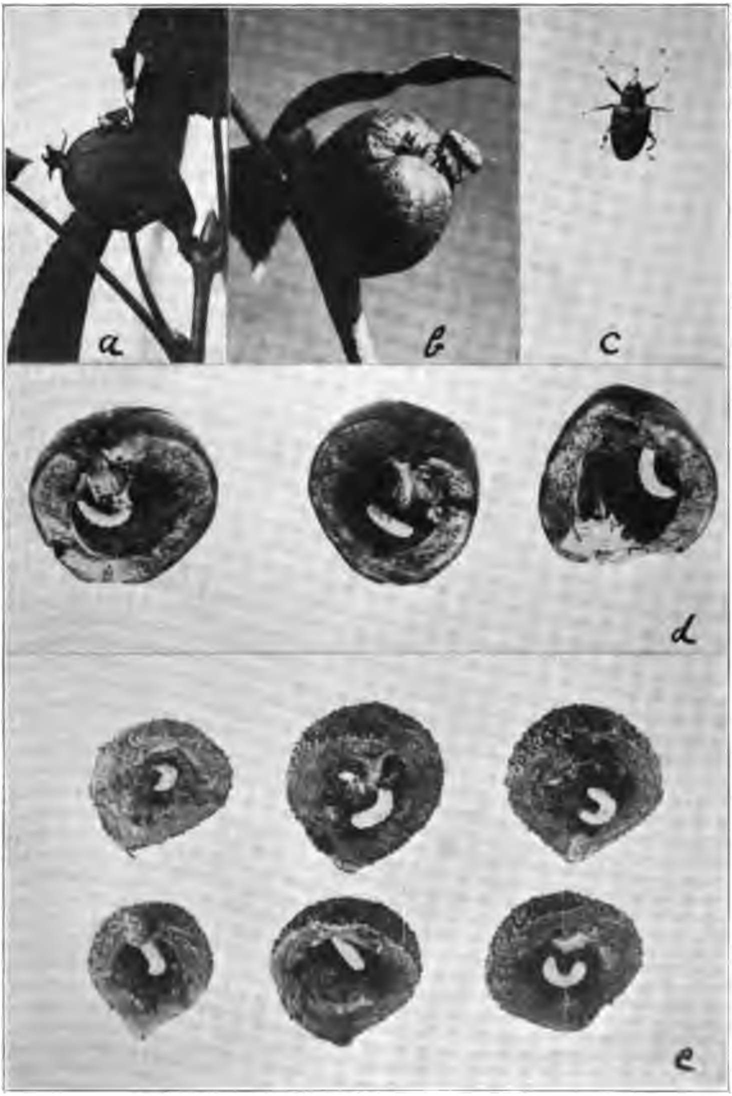
The two species that attack walnuts and hickorynuts often cause a heavy drop of the immature nuts. Very frequently trees of black walnut and of some varieties of hickory lose half their crop as a result of injuries inflicted by these insects. The infested nuts drop while they are quite small and for that reason the injuries are more apt to escape notice than when nuts are attacked that are more nearly mature.

THE WALNUT CURCULIO, *Conotrachelus juglandis* Lec.

During the month of July the ground beneath bearing black and white walnut trees will frequently be found well covered with little nuts that have recently fallen from the branches above. An examination of these nuts will show a crescent-shaped scar on the side of each and on cutting the nut open a small, whitish larva with a brown head will be found usually on the discolored tissue. A snout beetle known as the walnut curculio is responsible for this condition of the nuts.

The beetle is about one-fourth of an inch long and the snout, which hangs down or is folded back beneath the thorax, is less than half as long as the body. The back has a rough appearance which is due to several humps and ridges. The body is thinly covered with short, dingy-yellow hairs which form indistinct bands on each side of the prothorax and across the wing covers just behind the middle.

The first eggs of the season are deposited usually in young black walnuts about June 10th to 15th and oviposition continues for more than a month. In preparing a place for her egg, the beetle hollows out a cavity or pocket in the walnut about one-



Nut Curculios. a and b, Hickorynut Curculios; c, Walnut Curculio; d, larvae of Hickorynut Curculio in nuts; e, larvae of Walnut Curculio in nuts.

c, slightly enlarged. All the rest natural size.

tenth of an inch deep which extends obliquely beneath the skin. In this cavity the egg is placed and the beetle then proceeds to pack the space about the egg with bits of husk which she tears from the surface near where the opening was started. When the egg is well sealed in she enlarges the place from which she has torn the packing into a crescent-shaped incision, a little over an eighth of an inch long, which partly surrounds the egg.

As the beetle works she freely voids liquid excrement which forms a dark stain on the surface of the nut about a fourth of an inch from the wound. This stain on the nut is often more conspicuous than the wound.

Before the beetles have finished their egg-laying the walnuts are nearly half grown and the husk is so solid that excavating, as carried out so elaborately at first, becomes so difficult that the beetle, evidently to avoid labor, changes the form of her puncture and deposits the last of her eggs in shallow pits on the side of the nut. These eggs are placed in groups of three or four and have no crescent marks about them and are not protected with the plug of chips.

The egg is oblong-oval in shape, the color being creamy white. The surface is finely granular and has a ground-glass appearance. Length, .04 inch, width, .025 inch. Specimens that were observed hatched in four, five and six days, the average time being five days.

The larvae are dirty white with brown heads and are less robust and more active in their movements than those of the weevils. After the larvae have fed for about ten days or two weeks the nuts drop and the larvae complete their growth in from one to two weeks thereafter. They then abandon their feeding place, enter the ground for a short distance and soon pupate in small cells which they fashion in the earth. The beetles issue from the ground during August and September, and, presumably, spend the interval of warm weather about the trees. When fall approaches they hibernate, and reappear the following spring in time to attack the walnuts soon after the blossoms have dropped from the trees.

THE HICKORYNUT CURCULIO, *Conotrachelus affinis* Boh.

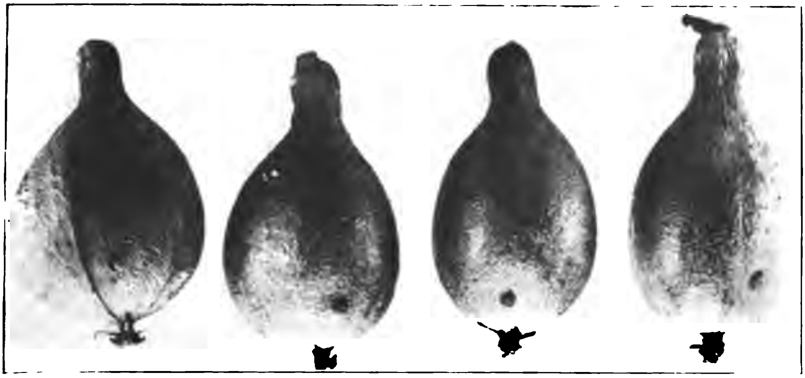
This insect injures hickorynuts in very much the same manner as the walnut curculio affects walnuts. As a rule the nuts when attacked are a little further developed than is the case with the walnuts, but the larvae appear and do their feeding before the kernel begins to form. The infested nuts drop when not more than two-thirds grown. The beetles seem to show a preferance for the nuts of pignut hickory, and some of the other less valuable varieties, but they also injure shellbark nuts considerably.

Superficially, the beetle bears a close resemblance to the walnut curculio, the most noticeable difference being that the broad band across the wing covers of the former are much lighter, in some individuals being almost pure white. The size and general structure of the two are very similar.

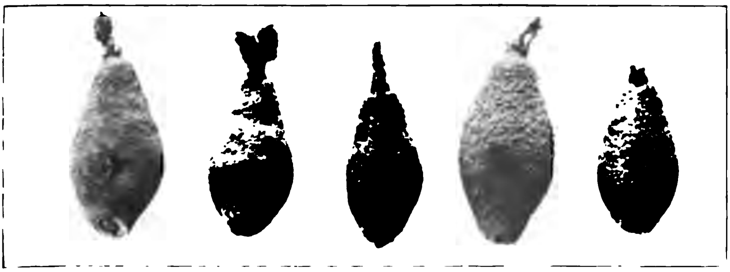
Egg-laying begins near the last of June and extends over a period of about four weeks. In 1906, oviposition had ceased apparently on July 15th but in 1907, when the season was about two weeks backward, egg production seemed to be at its height on July 20th. The eggs are placed in small cavities which extend less than half way through the husk of the nut. In one operation of egg-laying which was observed, the beetle spent 47 minutes in preparing a pocket for the egg, one minute in depositing the egg and 15 minutes in filling the space about the egg with scrapings from the husk. The last part of the act was performed after dark and was observed by the aid of a lantern. The beetles seem especially active in the early dark of the evening and it is probable that many of the eggs are deposited at that time.

The egg is oblong, eliptical in shape, surface smooth and glossy and the color clear white, the embryo showing through the shell. The dimensions of several specimens averaged;—length .04 inch, width .025 inch. One egg kept under obsevation hatched in five days.

The larvae are yellowish white with brown heads. In their



Egg-punctures in hickorynuts made by the Hickorynut Curculio. Natural size.



Egg-punctures in young black walnuts made by the Walnut Curculio. Natural size.

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feeding they convert the entire interior of the nut into fine, granular excrement.

Several nuts on the trees that were marked at the time eggs were deposited in them dropped in from 15 to 20 days thereafter. The larvae remain in the nuts for a week or two after they drop and then make their exit through holes eaten in the shell at the point where the wound was made in depositing the egg. They enter the ground to a depth of from one to two inches and soon change to pupae.

A few individuals were found that pupated in the nut. These were supposed, at first, to belong to another species but proved on reaching the adult stage to be the same as those that transformed in the ground.

Most of the young adults appear in August and September. My record for the first individual to issue in breeding jars is August 12th and for the last October 10th. The winter is passed in the beetle stage.

Mr. W. Dwight Pierce reared beetles of this species from fallen hickorynuts in Louisiana in July, 1906. (Entomological News, Vol. 18, 1907, p. 362.)

ACORN CURCULIOS.

In addition to the several species of Balaninus that depredate on acorns, a large number of two species of curculios were reared from infested nuts of white and chestnut oak. The habits of the two species are somewhat similar and in color and structure they are much alike. Both deposit their eggs in acorns in the fall and the larvae issue from the nuts during the succeeding winter and spring and enter the ground, where they transform to adults about mid-summer.

THE LARGER ACORN CURCULIO, *Conotrachelus naso* Lec.

This beetle is about the size and color of the walnut curculio, the most conspicuous difference being the longer and more slender snout. The color is dull brown mixed with black. On the back are several small spots of a lighter shade due to the dirty, white pubescence that sparcely clothes the body.

On September 24th, 1907 I watched one of these beetles depositing eggs in a chestnut oak acorn. It had selected an acorn that had the shell cracked so that there was no covering to penetrate in getting at the meat. The insect spent 15 minutes in making an egg chamber of the desired depth. She worked with considerable energy and every few seconds her beak would be withdrawn from the opening with a chip of the meat held in the jaws. These chips were placed in a small heap by the side of the opening and, when the excavating was done and the egg inserted, the chips were packed loosely about the egg until the cavity was filled. One of the beetles was seen feeding on a chestnut but no eggs were deposited in this nut.

This species was reared from both white and chestnut oak acorns, the beetles issuing from the earth in June and July. It has been bred in Texas from acorns of post oak.

The egg is creamy white, oval, .03 inch long and .015 inch wide, the surface being delicately granular. A dozen or more eggs may be deposited in one acorn.

THE SMALLER ACORN CURCULIO, *Conotrachelus posticatus* Boh.

This beetle is smaller than the one just described, the snout being shorter and stouter. The color and general appearance of the two species are similar.

The adults were not observed on the trees and no eggs of this species have come under my observation. They were reared abundantly from chestnut oak acorns. The adults issued from the ground in breeding jars during June, July and August. F. M. Webster has reared this species from white oak acorns and E. A. Swartz records that the larvae dwell within the galls of certain *Phylloxera* on hickory leaves. W. D. Pierce has bred it from prematurely fallen hickorynuts in Louisiana.

NATURAL ENEMIES.

The nut-infesting snout beetles are preyed upon by several kinds of insects and larger animals, but these natural enemies are not sufficient to keep them within the bounds of inoffensiveness.

The habits of these snout beetles are such that it seems impobable that we will ever be able to carry on a very successful warfare against them, and, since we can do so little in the way of holding them in check, it is interesting to know what nature is doing to retard their multiplication.

One of the most important of their enemies is a medium-sized, four-winged fly, a bracon parasite, known technically as *Urosigalphus armatus* Ashm. This parasite is a foe of the nut weevils and issues from the ground along with the beetles in the summer. It seems especially fond of the larger chestnut weevil and while the beetles of this species are laying their first eggs in the young chestnut burs the parasites fairly swarm among the branches. On August 28th, 1906, from a low-hanging chestnut branch that bore about seventy-five burs, I collected, in thirty minutes, 24 of the weevils and 26 of the parasites. Since that time they have been seen in equal abundance on numerous occasions.

This parasite has a long, external ovipositor, almost equal in length to the beak of the weevil. After the weevil has pierced the nut and inserted its egg, the parasite finds the same orifice, thrusts in its ovipositor and deposits an egg. The grub that hatches from the egg of the parasite feeds internally on the "chestnut worm," and although it opens hostilities soon after the weevil is hatched, it appears to cause its victim no serious inconvenience until the following year at just the time the weevil larva would pupate. Then the parasites kills and almost entirely devours the weevil. In the cell which the chestnut worm prepared for its own transformation quarters the parasite constructs a cocoon, four-tenths of an inch in length, within which it changes to the winged stage. Having reached maturity, it soon works its way to the open air and flies to the trees to prepare for another brood of parasites by laying its eggs in the weevils punctures.

The parasite has a wasp-like apperaance but if caught in the hand it will not sting although it gives off a very offensive odor. About 25 per cent of the larvae of the larger chestnut weevil are parasitized by this species and, apparently, a considerably smaller per cent of these of the other species of Balaninus.

It seems probable that the habits of plastening over their egg-punctures and of hiding their eggs in the side branches of the main galleries, which are practiced by some of the acorn weevils, are devises for outwitting this parasite.

A smaller bracon parasite, known as *Sigalphus curçulionis* Fitch, was reared in abundance from the larvae of the hickorynut curculio and in lesser numbers from those of the walnut curculio.

A number of small, brown ants, *Lasius aliena* Fors., were found that had broken into the earthy cell of a larva of the larger chestnut weevil and were devouring the insect. Another species of ant somewhat larger than the one mentioned first and known as *Aphaenogaster aquia* Buck., was found with a number of partly eaten Balaninus larvae stored in its nest under a stone in the woods. Still another species, a small, red ant, *Solenopsia debilis* Mayr., was found attacking larvae of the walnut curculio within young black walnuts on the ground.

Several specimens of two parasitic flies, about the size of the common housefly, were bred from the nut enemies. One of these, *Metadexia basalis* G.-T., was bred from the larva of the hickorynut curculio and the other, *Myophasia aenea* Wied., was reared from white oak acorns infested with the larvae of *B. pardalus and C. naso.* From which species the fly came, was not determined.

The larva of an undetermined click-beetle was found feeding on a larva of one of the nut weevils, and on another occasion a nymph of the spined soldier-bug. *Podisus maculiventris,*

Larvae and pupae of Larger Chestnut Weevil. Natural size.

Cocoons of a parasite of nut weevils, *Urosigalphus armatus*. Natural size.

The Short-tailed Shrew. An enemy of nut insects.

was found with a live, adult larger chestnut weevil impaled on its beak, which it soon killed. ,

Perhaps the most important enemy of these snout beetles, especially of the nut weevils, is the short-tailed shrew, a little, insectivorous mammal that lives in the ground. These little shrews are not often seen but they are exceedingly abundant, especially in woods and in shady and weedy places in fields. They are very fond of the fat, juicy grubs of the snout beetles, and while these grubs are in the ground undergoing transformation or hiding for the winter, they are found by shrews and devoured by thousands. In the ground beneath nut-bearing trees a labyrinth of burrows will be found frequently that have been made by the shrews in their search for insects. In such places not more than 10 per cent of the larvae that enter the ground in the fall can be found the following spring. That the shrews are chiefly responsible for their disappearance is shown by the numbers of the mammals that can be trapped in such places and by their fondness of the larvae when in captivity. It has been found that a shrew in 24 hours will eat a quantity of the larvae greater in weight than that of its own body. On one occasion, I saw a shrew devour 70 large "chestnut worms" within a space of five minutes.

For further notes on this feeding habit of the shrews, see Bulletin 113, W. Va. Agr. Expt. Station.

METHODS OF CONTROL.

This is a difficult group of insects to deal with so far as remedial measures are concerned. The internal feeding habits of the larvae, and to a great extent of the adults also, together with the fact that most of the activities of the more injurious species are carried on in the tops of large trees, places them beyond the reach of our ordinary insecticides.

All the species, being native to this country and having their wild food plants, propagate their kind in the woods and furnish from that source an abundant supply of recruits to take the places of any that may be destroyed in cultivated nut orchards and groves. The case is not hopeless, however, and some very satisfactory results are being obtained by a few persons who are producing and handling nuts on a large scale.

FUMIGATION WITH BISULPHIDE OF CARBON. This material may be obtained at most drug stores at a cost of about 25 cents a pint in small quantities. Fumigation with it is recommended for nuts when they are first harvested. The treatment kills many of the larvae within the nuts before they have attained much size, and renders the nuts more salable, although it may be a question as to whether or not the consumer should be pleased with this manner of hiding the defective kernels.

In using this treatment, a light box or barrel is provided of a size sufficient to accommodate the quantity of nuts to be fumigated. The nuts are placed in the receptacle and a shallow dish set on top of them. Into this dish the bisulphide is poured, from half an ounce to an ounce being used for each bushel of nuts. The receptacle containing the nuts should be furnished with a tight fitting lid and this should be put in place at once after the liquid is poured into the dish. The nuts should then be left undisturbed for from twelve to twenty-four hours.

The bisulphide of carbon volitlizes very rapidly and the gas which is thrown off, being heavier than the atmosphere, settles to the bottom of the vessel, penetrating the shells of the nuts and killing the insects within. The tighter the receptacle containing the nuts the less bisulphide will be required and the more effective will be the treatment. It may be necessary to repeat the fumigation in about ten days to kill the young larvae that hatch from eggs that were in the nuts at the time of the first treatment.

The bisulphide of carbon has a very disagreeable odor but this passes off quickly after the nuts are exposed to the air. In using this material care should always be taken to keep fire away as the gas is very inflammable.

DESTROYING INFESTED NUTS. The larvae of most of the species of weevils and curculios remain in the nuts for some time after the nuts drop to the ground. If such nuts are gathered carefully and thoroughly and the worthless ones fed to hogs or burned many larvae will be destroyed and the generation of beetles that would injure the next season's nuts be greatly reduced.

CULTIVATION. Cultivation of the soil about nut trees is not often practiced in this section of the country, but, where practicable, spring and summer cultivation may be counted on to destroy many of the insects by breaking up their hiding places in the earth and exposing the larvae and pupae to the air and to natural enemies.

TRAPPING THE BEETLES. On a previous page of this paper the habit which the adult hickorynut weevil has of hiding in dead leaves that adhere to the branches is alluded to. The tendency to hide in these brown, curled leaves is so great that in at least one instance when a medium-sized bearing hickory tree was examined, practically every dead leaf on the branches that could be reached by climbing contained one or more beetles. On that occasion none was found in any other situation. In a small way, I experimented with hanging twigs covered with dead leaves to the branches and on the body of the tree at about the time the beetles were most abundant. I had no difficulty in trapping a considerable number of beetles in this way, and found that the insects could be destroyed very easily by dipping the leaf traps into hot water.

It is possible that in pecan and hickory groves much good might be accomplished by trapping in this way with bunches of dead leaves or with some other device that would afford shelter for the insects. The method might be extended to some of the other species of nut weevils but, from our knowledge of their habits, it may be said that the hickorynut weevil is the most promising species for experiments of this kind.

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BULLETIN 129 JULY, 1910

Construction of a Silo

HORACE ATWOOD.

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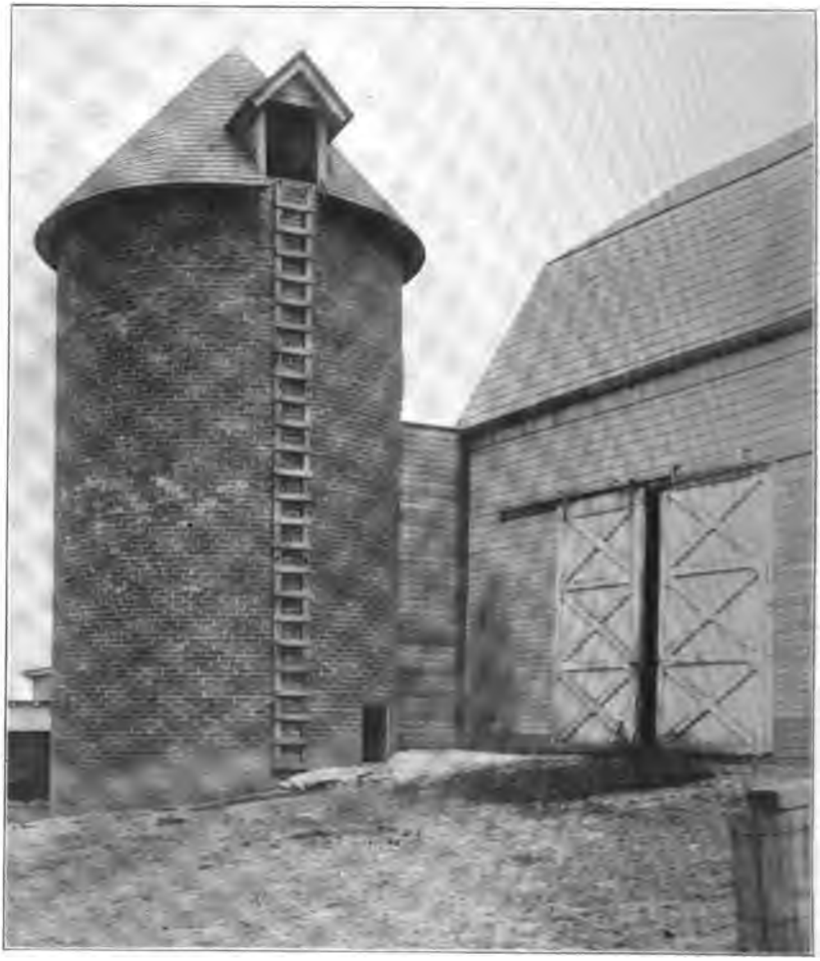

A REINFORCED BRICK SILO

A Reinforced Brick Silo.

IMPORTANCE OF SILAGE FOR DAIRY COWS.

On a dairy farm a silo is almost a prime necessity, and the dairymen of West Virginia are fortunate that corn, the King of silage plants, can be grown so easily in nearly all sections of the state. During summer there is nothing cheaper or more satisfactory for milch cows than good pasture, but in winter all the feed must be provided, and at the prevailing high prices for hay and grain it is important to produce on the farm as much of the ration as possible. The growth of corn for the silo fulfulfils this condition, as heavy yields can be secured when the soil is properly fertilized and the crop intelligently cultivated. Silage, too, is succulent, adds variety to the ration, is relished by the animals, and promotes a more healthful condition of the digestive system than when dry feed only is supplied. Moreover, corn silage can be produced cheaply, thus reducing the cost of the ration of which it is a part.

It is not the purpose of this bulletin to enter into an extended discussion of the principles underlying the construction of silos, or of the use of silage for dairy animals, as detailed information may be obtained about these matters by writing to the U. S. Department of Agriculture, Washington, D. C. for the Farmers' Bulletins on this subject**. It is sufficient at this time to say that for a silo to be satisfactory the walls must be air tight, and sufficiently rigid to withstand the pressure to

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**Information regarding silos and silage is contained in the following Farmers' Bulletins of the U. S. Department of Agriculture: No. 32, "Silos and Silage"; No. 292, "Cost of Filling Silos"; No. 56, pp. 7-9, "Robertson Silage Mixture"; No. 103, pp. 20, 21, "Silage for Horses and Hogs," and pp. 23-30, "The Stave Silo"; No. 124, p. 25, "Alfalfa Silage"; No. 133, pp. 31, 32, "Losses in the Preparation of Silage"; No. 190, pp. 21-23, "The Octagonal Silo"; No. 222, pp. 31, 32, "Silage in Place of Grain for Dairy Cows"; No. 267, pp. 29-31, "Effect of Silage on the Flavor of Milk"; No. 309, p. 19, "Silage from Frosted Corn."

which they are subjected when the silo is filled with heavy green material. For ordinary silos filled with corn silage this pressure increases eleven pounds per square foot for each foot in depth of the silo. Consequently the outward pressure becomes very great at the bottom of deep silos. The wall must be strong enough to withstand this pressure for if cracks open air is let in and the silage rots.

The silo should be of sufficient depth so that the weight of the silage compresses itself thus excluding the air. Few silos are now being built less than thirty feet deep. The greater the depth of a silo the greater its relative capacity on account of the fact that the silage packs in more solidly. One silo thirty feet deep will hold more silage than two silos each fifteen feet deep, all being of the same diameter, to say nothing about the superior quality of the silage in the deeper silo. With the modern ensilage cutter with blower attachment, a deep silo can be filled as easily as a shallower one, although somewhat more power is required.

FEEDING AREA.

As silage soon spoils when exposed to the air it is usually removed by raking from the top a sufficient amount for each feed, care being taken to disturb the underlying silage as little as possible. In this way the fresh silage which is continually being exposed is fed before sufficient time has elapsed for it to mold. The depth of silage which should be removed each day in order to keep ahead of decay depends somewhat upon the weather, as silage decays more slowly at low temperatures. In general from one and one-half to two inches in depth should be removed daily, and the size of the silo should be so proportioned to the number of stock kept that this result can be accomplished. A cow will consume about forty pounds, or one cubic foot of silage daily, and with this figure in mind it is easy to calculate the proper size of the hortizontal feeding area of a cylindrical silo. For example if twenty-five cows are kept, about twenty-five cubic feet or 43,200 cubic inches of silage will be fed daily.

Dividing this by 2, the depth to be fed daily, we obtain 21,600 the required horizontal feeding area of the silo in inches. Dividing this by 3 1-7 and extracting the square root of the quotient we obtain approximately 83 which represents one-half of the inside diameter of the silo in inches, or a total inside diameter of 166 inches or approximately 14 feet.

CAPACITY OF SILOS.

The following table gives the approximate weight in tons of well matured corn silage that may be stored in cylindrical silos of various heights and diameters:

DEPTH OF SILO FEET	INSIDE DIAMETER OF SILO, FEET.												
	10	12	14	15	16	18	20	21	22	23	24	25	26
20	26	38	51	59	67	85	105	115	127	158	151	163	177
21	28	40	55	63	72	91	112	123	135	148	161	175	189
22	30	43	59	67	77	97	120	132	145	158	172	187	202
23	32	46	62	72	82	103	128	141	154	169	184	199	216
24	34	49	66	76	87	110	135	149	164	179	195	222	229
25	36	52	70	81	90	116	143	158	174	190	206	224	242
26	38	55	74	85	97	123	152	168	184	201	219	237	257
27	40	58	78	90	103	130	160	177	194	212	231	251	271
28	42	61	83	95	108	137	169	186	204	223	243	264	285
29	45	64	88	100	114	144	178	196	215	235	265	278	300
30	47	68	93	105	119	151	187	206	226	247	269	292	315
31	49	70	96	110	125	158	195	215	236	258	282	305	330
32	51	73	101	115	131	166	205	226	258	271	295	320	346

In this connection it may be well to observe that a silo thirty feet deep will furnish silage for practically six months when fed from at the rate of two inches in depth daily. Under ordinary conditions this will cover the feeding season unless silage is required to supplement pasturage.

WHEN TO CUT CORN FOR THE SILO.

Corn for the silo should be cut just before it becomes fully mature. At that time there is still enough juice in the stalks so that the cut or shreaded material packs into the silo firmly and yet there is not that earlier superabundance of juice whose presence tends to produce a very sour or acid silage. During the latter part of the growing period, the accumulation of nutritive materials in the corn plant is very rapid, so on this account also harvesting should be delayed until the crop is practically mature. When the lower leaves become dry and some of the ears are ripe enough to be snapped off for seed the crop is ready to be stored away. On the approach of cold weather if the corn is still immature it is better to take the risk of a slight frost rather than to cut the corn too green, as the accumulation of nutritive materials at this time will usually more than offset any ordinary damage from frost.

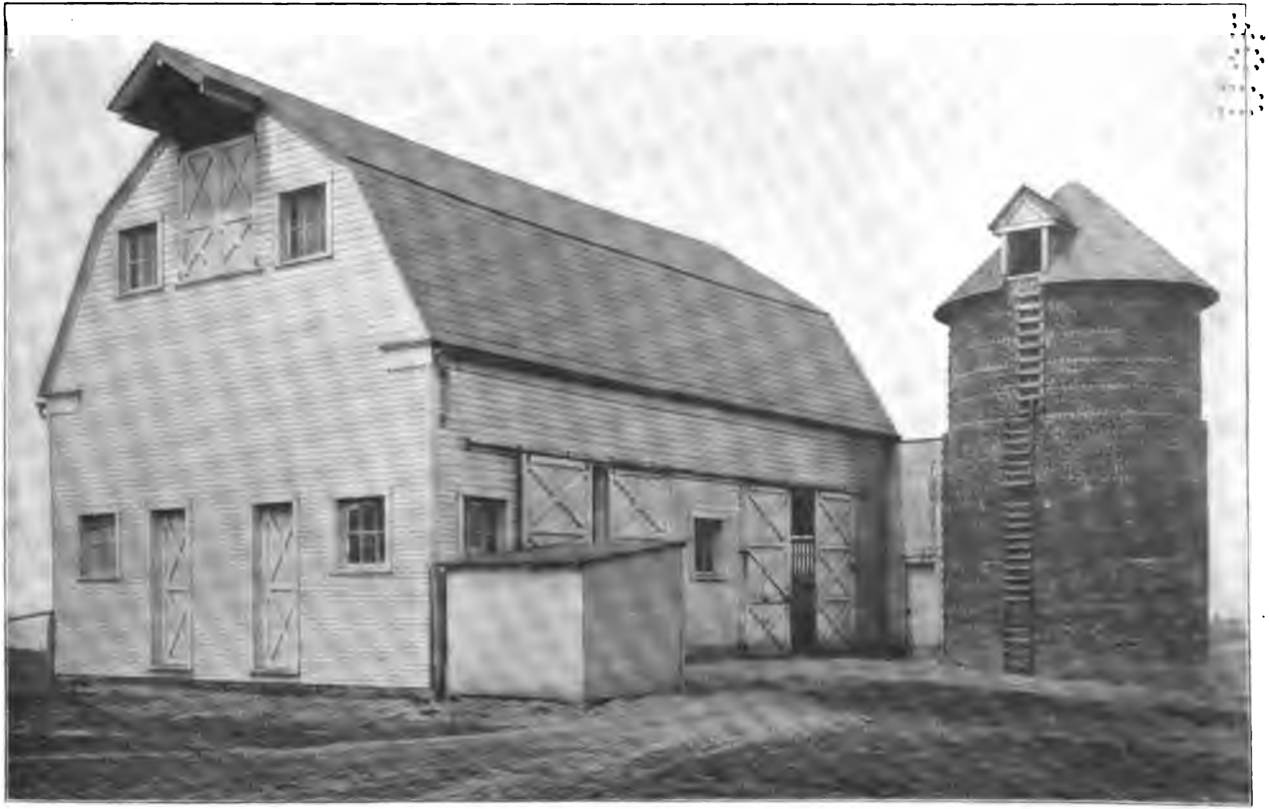
SILO CONSTRUCTION.

In the past most silos have been built of wood, in cylindrical form, the height being about twice the diameter. Wood, however, at the best is not an ideal material for silo construction as the walls take up moisture and swell when the silo is filled, and then shrink when the silo is empty. This swelling and shrinking tends to open the joints so that the walls do not remain air-tight and loss of silage results. After a time, too, wooden walls may rot, thus letting in air, and stave silos when empty are easily racked out of shape by the wind or blown down.

Many silos are now being constructed of cement or concrete, reinforced with iron rods or wire, and although these silos when properly built are giving perfect satisfaction, yet the forms necessary for their construction are somewhat expensive, and few farmers care to undertake the construction of cement silos without having had some previous experience. Directions for building solid wall or cement block silos may be obtained by writing to the Atlas Portland Cement Company, New York City, for a copy of "Concrete Construction about the Home and on the Farm." This pamphlet is distributed gratis.

BRICK SILOS.

In 1904 the Experiment Station constructed the brick silo shown in Fig. 1. This silo is fifteen feet in diameter and thirty feet deep.



THE STATION BARN AND BRICK SILO. (Fig. I.)

The brick were laid in cement and the silo was plastered on the inside with cement mortar. Iron rods about six feet long were imbedded in the mortar above and below each door so as to give strength to that portion of the wall. No other reinforcement was used. The wall is a brick and a half or about thirteen inches thick for two-thirds of the way and the remainder is eight inches thick, exclusive of the plastering, which is about three-fourths of an inch in thickness. This silo has been used continuously since it was built and has given good satisfaction as no cracks have appeared in the wall and the silage has kept well.

REINFORCED BRICK SILOS.

The silo described above not being large enough for the increasing number of animals kept on the Experiment Station Farm it became necessary during the summer of 1909 to build another silo and an attempt was made to construct a silo possessing all of the advantages of a brick structure and yet reduce materially the first cost. Reinforced brick construction was decided upon.

METHOD OF CONSTRUCTION.

An excavation was made about four feet deep to the underlying rock in order to secure a solid foundation. Then a cylindrical brick wall was laid up the width of a brick or four inches thick, cement mortar being used. As the wall was laid 20d wire nails, which previously had been annealed by heating them, were imbedded in the mortar with the ends projecting from the wall about two inches into the silo. About two nails were used per the square foot of surface.

After the wall had stood a few days for the cement mortar to harden, Page woven wire fencing was cut into pieces of the proper length to go around the inside of the silo, lapping somewhat, and the projecting ends of the nails were clinched over the wires so as to hold the fencing close to the brick wall. Page fencing with "coiled" wire is not well adapted to this purpose as the coil will not permit the fencing to be applied smoothly and evenly to the wall. Only fencing with straight horizontal wires should be used for this purpose, for if the fencing is not drawn close to the wall in all places an unnecessary amount of cement is required for the plastering.

Two thicknesses of wire fencing were put on for about one-half of the depth of the silo and for the remainder only one thickness. Each strip of fencing as put on was lapped about two inches over the lower one. The top course of fencing was allowed to project about four inches above the top of the wall and this was stapled to the plate thus fastening the roof securely to the structure.

After the wire was in place the inside of the silo was plastered with cement mortar, thus covering the wire. The mortar consisted of one part of cement and three parts of sand.

Four openings were provided at convenient distances for removing the silage. These openings are each twenty-four by thirty inches in size. The door frames are of cast iron, one inch in thickness with a projection which laps a couple of inches over the brick work on the inside of the silo. There is also a projection an inch high extending around the frame on the inside and two inches from the face of the frame and against which the door presses when in place.

The doors were made, as is customary, of two thicknesses of seven-eighth inch flooring with roofing paper between, and they are held in place by being bolted to four by four inch pieces of timber which extend across the door frames on the outside. The nuts on the bolts which pass through the doors and the pieces of timber are tightened from the outside and in this way the doors can be drawn snugly against the jamb of the door frames.

This silo has been used only one year but the silage has kept well, and the wall successfully withstood the internal pressure.

It is believed that this method of construction possesses many advantages where a permanent structure is desired. The wire fencing, being protected by the coating of cement, has no tendency to rust, and the life of the silo should be almost indefinite. In every agricultural community the services of a brick mason can be secured easily, the job of laying up the four inch wall is a short one, and the farmer himself can put on the wire and do the plastering.

The following schedule shows the amount of materials used, the cost of the same and the cost of construction, but, as pointed out above, all of the work except laying the brick can be done by common farm labor, and under these conditions the actual cash outlay would be much less than that shown below.

MATERIALS USED AND COST OF CONSTRUCTION FOR SILO FIFTEEN FEET IN DIAMETER AND THIRTY FEET DEEP.

8,600 brick	$59.20
Laying brick	76.39
233⅓ bushels sand	4.66
9½ bbls. cement	19.00
Plastering silo	41.20
3 rolls Page woven wire fencing	14.00
½ keg of 20d wire nails	1.50
Lumber for roof	38.90
3,250 shingles for roof	13.00
Carpenter putting on roof and building doors	15.00
4 cast iron door frames	18.18
Labor excavating foundation	12.00
Total cost	$313.03

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 130. SEPTEMBER, 1910

Construction of a Modern Poultry House and Report of Experiments in Hopper Feeding Laying Hens

BY HORACE ATWOOD

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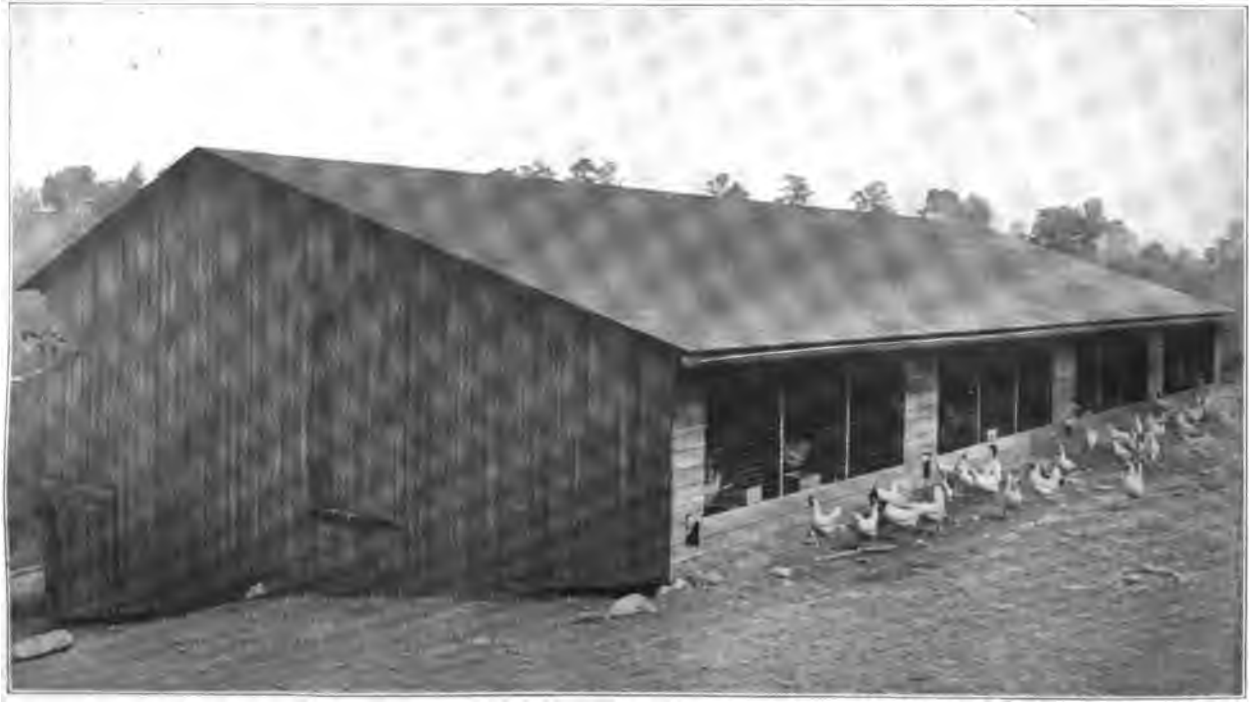
*Deceased.



OPEN FRONT LAYING HOUSE

Experiments in Hopper Feeding Laying Hens

In the production of eggs the main items of expense are for the food required by the fowls; for labor to care for them; for repairs to the buildings and equipment; and for systematically replacing each year the older individuals with younger and more productive birds. The amount and the cost of food required by a fowl in the course of a year has been set forth in former bulletins of this Station.

The cost of labor to care for a fowl for a year depends upon several factors among which may be mentioned the number of fowls kept, the manner in which they are housed, fed and watered, and the facilities for cleaning and keeping the houses in a sanitary condition, and free from lice and mites. As no two poultry houses are the same in all respects it is quite probable that the labor cost of caring for fowls varies widely in different sections of the country and under different conditions.

In an address delivered before the American Poultry Association it was stated that on a certain poultry plant in Maine where two thousand hens are kept in a long laying house the labor cost is thirty-six cents per hen per year. This did not cover the cost of removing the soiled litter, and replacing it with straw or other scratching material.

In this particular instance the cost of labor per fowl, per year, was apparently about one-third as much as the cost of food. On many other egg farms where the arrangements are not so convenient as in the case mentioned it is entirely probable that the labor cost for caring for fowls may amount to one-half as much as the cost for food or perhaps even more.

In practice it is just as important to economize in respect to the cost of labor as it is to increase the egg yield by skillful feeding or breeding, as in both cases the object is to lower the cost of production.

Is there any way of feeding fowls which requires little time and attention and yet which gives good results with respect to egg yield?

HOPPER FEEDING.

On many farms it has been the custom in the past to feed once per day a mash composed of ground grain, beef scrap, etc., moistened with water. Moistening the ground feed and placing it in troughs for the fowls requires considerable time. Experience and good judgment are also required in order to feed just the proper amount. If too much mash is fed the excess is usually wasted, and if not enough is supplied the egg production is restricted to that extent.

In the hopper system of feeding, the grain or dry mash is placed in suitable receptacles so that the fowls can help themselves at will. This materially reduces the cost of labor in feeding the fowls, but do they lay as well? The experiment described below has been performed for the purpose of beginning the study of this subject.

The experiment began December 8th, 1905, with four lots of fowls each consisting of twenty single comb White Leghorn pullets. On January 17, 1906, another pen of twenty White Leghorn pullets was added to the test and the record of this pen also is given. The pullets added to the test in January were hatched later in the season than those in the other four pens and were practically of the same age and weight when added to the test as the other pullets were at the beginning, and it is believed that the results derived from all five pens are to a certain extent comparable. The test was continued for one year.

The method of feeding each pen was as follows:

Pen 1. This lot of fowls was fed shelled corn, beef scrap, and wheat bran, in hoppers constructed so that there was a supply of these feeding stuffs constantly before them. The general health of these fowls was apparently good, although the mortality was heavy, four dying in the course of the year. Those which died were fat and heavy and probably the cause of death was enlargement of the liver.

Pen 2. This pen was hopper fed with corn, beef scrap, and a mixture of equal parts by weight of corn meal, wheat bran, and ground oats. For the first month the corn, beef scrap and ground feed was supplied ad libitum, but as the egg production was very unsatisfactory with a supply of corn constantly before the fowls, the practice was adopted for the remainder of the year of closing the corn orifice early in the morning and opening it again at night when picking up eggs. The fowls in this pen, then, had access to beef scrap and ground grain during the day, and to shelled corn for a short time at night and morning. Three hens died in this pen, one from prolapsus of the oviduct, one was crop bound and the other died from some undetermined cause.

Pen 3. This pen was hopper-fed with (1) a mixture of equal parts by weight of corn, wheat, and oats; (2) beef scrap; and (3) a mixture of equal parts by weight of corn meal, ground oats and wheat bran. As the corn, wheat and oats were mixed together it was thought that it would be possible to make the fowls eat the oats as well as the wheat and corn. It was found in practice, however, that after the oats had accumulted to a certain extent in the trough of the self-feeder they were thrown out by the fowls and some unavoidably wasted, thus making the recorded food consumption for this pen abnormally high. There was no mortality.

Pen 4. This pen of fowls was fed a moistened mash in the morning consisting of a mixture of corn meal, wheat bran, ground oats and beef scrap. Toward evening a mixture of whole grain was scattered in the litter covering the floor of the house. There were no deaths.

Pen 9. This flock was hopper fed with a mixture of equal parts by weight of corn meal, wheat bran and ground oats. In another compartment of the hopper beef scrap was supplied. Once per day a mixture of whole grain was scattered about in the litter so as to induce the hens to take exercise. Two hens died, the cause of death was not determined.

The fowls in this test were confined to the houses and runs described in former bulletins, the houses being about ten feet wide and twenty feet long and the runs about thirty feet wide by a hundred feet long. No green food was supplied them in winter, but in summer a fair quantity of green stuff grew in the runs but the supply toward fall became limited. In all cases the food was weighed out carefully in bulk for each pen by the Assistant Agriculturist but the actual feeding was intrusted to a farm laborer.

The following table shows the average weight of the hens at the beginning, and end of the test; on May 21st; and on August 25th.

TABLE SHOWING WEIGHT OF FOWLS.

	1905	1906				1907
Pen.	Dec. 8	Jan. 17	May 21	Aug.25	Dec. 8	Jan..17
1......:	3.50		3.32	3.12	3.70	
2......	3.48		3.30	3.45	4.00	
3......	3.45		3.22	3.15	3.85	
4......	3.50		3.12	3.10	3.77	
9......		3.52	2.98	3.00		3.77

During May and August the fowls were not so heavy as at the beginning of the test. At the close of the year, however, all of the fowls were somewhat heavier than at the beginning.

The following table shows the amount and kind of food consumed by the various pens of fowls during the year:

POUNDS FOOD CONSUMED.

Pen	Corn	Wheat	Oats	Corn Meal	Wheat Bran	Ground Oats	Beef Scrap	Total
1.......	1024.3				115		50	1189.3
2.......	865			142	142	142	91	1382
3.......	385	375	375	102	102	102	79	1520
4.......	288	288	288	145	145	145	90	1389
9.......	276	276	258	142	148	144	148	1392

The table shows the pens 2, 4 and 9 consumed almost exactly the same amount of food, or in round numbers practically seventy pounds per fowl. The food consumption of pen 1 was slightly less than in the case of pens 2, 4 and 9, and pen 3 stands higher, probably due to wastage as already noted.

The following schedule of prices has been used in calculating the cost of feed consumed by the fowls. These prices represent as accurately as could be determined the average retail prices which prevailed in Morgantown during the year covered by the test.

Corn $1.08 per hundred.

Wheat $1.50 per hundred.

Oats $1.40 per hundred.

Corn Meal $1.25 per hundred.

Wheat bran $1.25 per hundred.

Ground oats $1.50 per hundred.

Beef scrap $2.25 per hundred.

The following table gives the cost of the food consumed by the experimental pens during the year.

COST OF FOOD.

Pen	Corn	Wheat	Oats	Corn Meal	Wheat Bran	Ground Oats	Beef Scrap	Total
1......	$11.06				1.44		1.12	13.62
2......	9.34			1.77	1.77	2.13	2.04	17.05
3......	4.15	5.62	5.25	1.27	1.27	1.53	1.78	20.87
4......	3.11	4.32	4.03	1.81	1.81	2.17	2.02	19.27
9......	2.98	4.14	3.61	1.77	1.85	2.16	3.33	19.84

The table shows that pen 1, fed principally upon corn, was fed for the least money. Next in order stands pen 2, followed in turn by pens 4, 9 and 3. The total cost of food for the year for the hundred fowls which were in this test was $90.65, or slightly more than ninety cents per fowl.

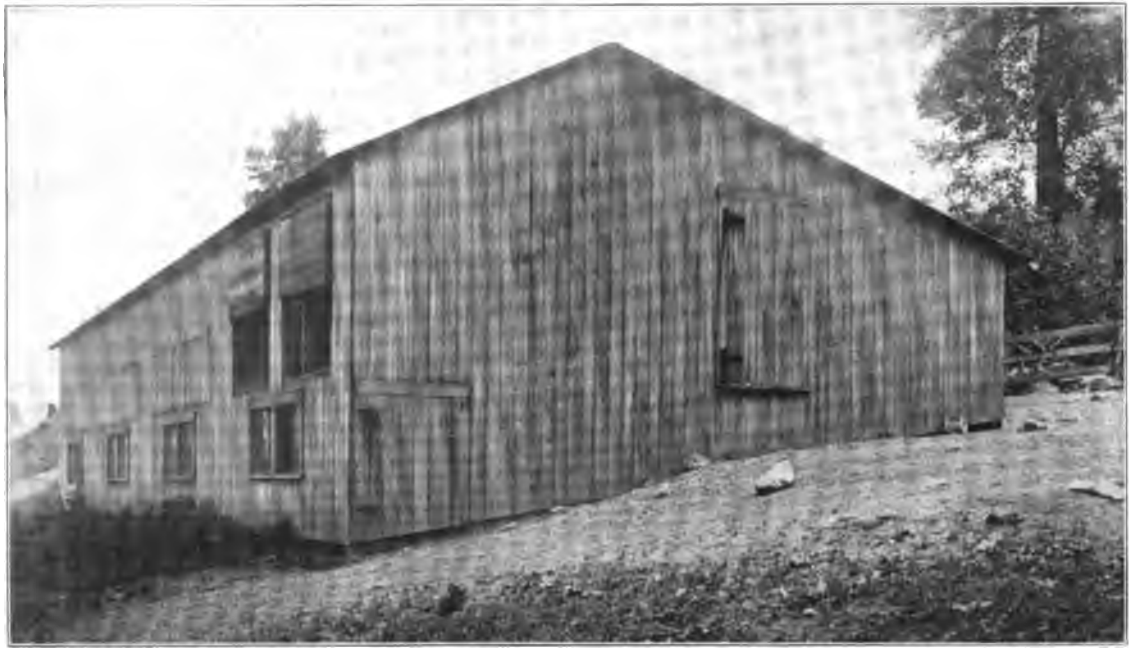
The following table shows the egg production by months for the different lots of fowls:

	Pen 1	Pen 2	Pen 3	Pen 4	Pen 9
1905					
Dec. 8	71	46	80	118	...
1906					(Jan. 17)
Jan.	61	138	37	140	69
Feb.	152	199	139	149	232
Mar.	288	398	357	390	406
Apr.	258	357	300	334	332
May	202	295	300	300	323
June	205	299	286	287	299
July	169	278	238	253	323
Aug.	141	227	220	195	241
Sept.	36	99	86	57	172
Oct.	14	23	20	21	52
Nov.	24	32	13	68	...
Dec.	7	16	24	21	27
1907					
Jan. 17	...	...	...	...	19
Total	1628	2407	2100	2333	2495

The egg production was not especially heavy with any of the pens of fowls. The best record was made by pen 9, which was hopper fed with mash and beef scrap, and with whole grain once per day scattered in deep litter. Next in order stands pen 2, which had access to corn in a hopper for a short time in the morning and evening. Materially behind all of the other pens, and with a remarkably low egg record, is pen 1, which received corn, beef scrap and wheat bran ad libitum.

The following table shows the average food cost of the eggs per dozen and the cost of food per hen per year.

	Cost of eggs.	Cost of food per hen per year.
Pen 1	10 cts. per doz.	68 cts.
Pen 2	8.5 cts. per doz.	85 cts.
Pen 3	11.9 cts. per doz.	104 cts.
Pen 4	9.9 cts. per doz.	96 cts.
Pen 9	9.5 cts. per doz.	99 cts.



END AND REAR VIEW, SHOWING TWO OF THE VENTILATING SHUTTERS OPEN

The table shows that the food cost of the eggs produced by the different pens during the year varied from 8.5 cents to 11.9 cents per dozen. Pen 2 leads in respect to low cost of eggs, while pen 1 leads in respect to the cheapness of the ration. The hopper fed pens, 2 and 9, produced eggs having a lower food cost, and those laid by pen 1 cost only slightly more, than those laid by pen 4 which received moistened mash.

SUMMARY.

1st. In a year's test with five pens of fowls the cost of food varied from eighty-five cents to one dollar and four cents per fowl per year, and averaged ninety cents per fowl for the one hundred fowls in the experiment.

2nd. The egg production varied from 81.4 eggs per hen in the case of pen 1, fed principally upon corn, to 124.7 in the case of pen 9, which received whole grain once per day, scattered in litter, and dry mash and beef scrap ad libitum in a hopper.

3rd. The food cost of the eggs during the year varied from 8.5 cents to 11.9 cents per dozen.

4th. Two pens, hopper fed, produced eggs having a lower food cost than the pen which received moistened mash, and in this test there was apparently no benefit from the extra labor involved in moistening the mash.

AN OPEN FRONT LAYING HOUSE.

In Bulletin No. 115 of this Station is given a description, together with working drawings of the curtain front laying house which was erected on the Station farm some years ago. This house has continued to give satisfaction in respect to the comfort and health of the fowls. It has been found, however, that the double wall on the north side of the house is an excellent harbor for rats and this method of construction should be avoided in building poultry houses. Recently another house has been erected of a different type, and as it also seems to be well adapted to West Virginia conditions a description of it should be of interest to West Virginia poultrymen.

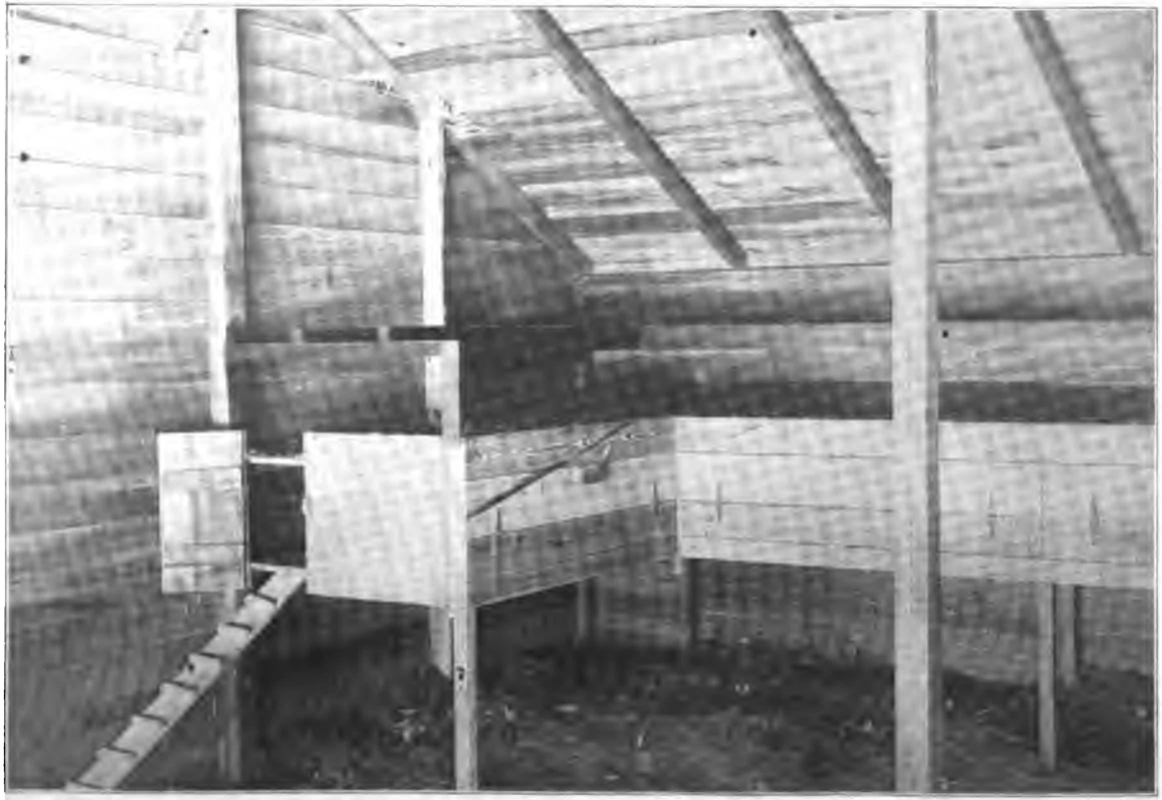
The house under discussion is of the open front or Tolman style, and is characterized by having the front completely open or covered only with wire netting in order to keep out stray animals or vermin. The house is twenty-four feet wide and sixty-four feet long and is divided by solid board partitions into four sections, or rooms, each sixteen feet wide and twenty-four feet long. The house is five feet high in front and six above the basement or scratching room in the rear. The roof is of unequal span, the peak being located two thirds of the distance from the front to the rear, and having an elevation above the floor of ten and one-half feet.

Being located on sloping ground, the house was provided with a scratching shed underneath. This portion is about four feet high with a dirt floor and the fowls gain access to it through trap doors placed in each section. This provides a place for the fowls to dust themselves and exercise in winter and is a very desirable feature.

The perches are on a level with the front opening. In winter when the fowls have gone to roost the warm air resulting from their presence tends to collect in the upper portion of the house maintaining a comfortable temperature even in severe weather. Last winter with its zero temperatures the combs of S. C. White Leghorn hens were not frozen even when the front of the house remained constantly open. In poultry houses having a shed roof the warm air constantly flows away from the fowls, when they are on the perches, thus making the shed roof type of house somewhat colder for the fowls at night.

In order to keep the house cool during the warm season two doors are provided in the rear wall of each section of the building, opening underneath the nest boxes. When these doors are open, as in summer, the wind has unobstructed passage through the house and the fowls when on the perches remain comfortable even on very sultry nights.

This house has been in use for a year and seems to be well



INTERIOR VIEW SHOWING OPENING TO NEST BOXES UNDERNEATH THE PERCHES adapted to West Virginia conditions. It should face the south or southeast, and if a wind break is provided opposite the open side so much the better.

One of the advantages of this house is that the fowls always have plenty of fresh air and consequently remain healthier than where they are compelled to breathe impure air too often found in poultry houses. The free circulation of air too prevents any condensation of moisture on the walls of the building during frosty weather, and the litter on the floor constantly remains crisp and dry. Fowls remain healthier in a cold dry house than in a warm damp one.

The house was built by contract and cost $450, complete. Four hundred Leghorns can be housed comfortably in it.

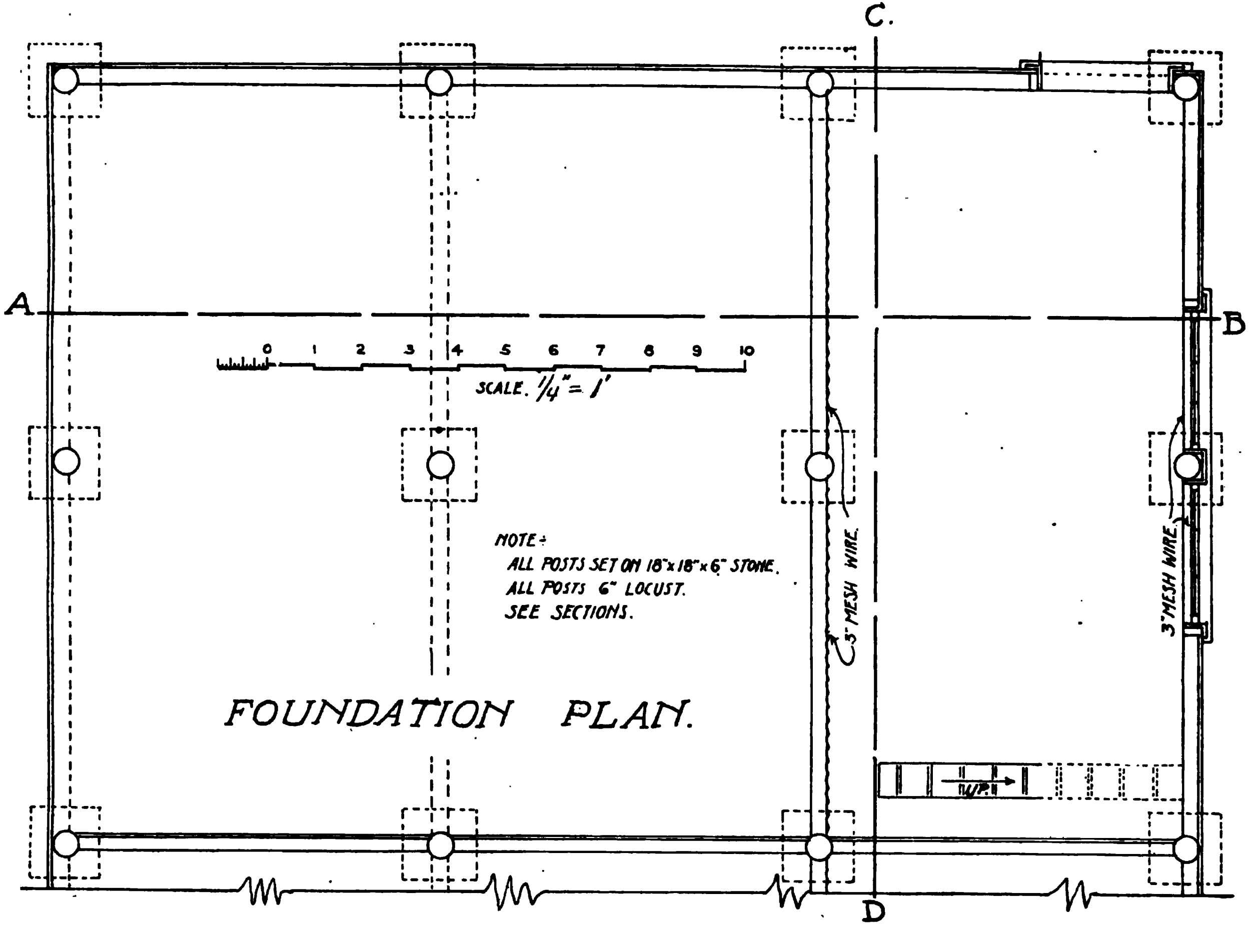
The cuts drawn to scale show the details of construction, and the bill of material for one section of the house including both sides is appended hereto. If two or more sections are constructed multiply the amount of material required for one section by the number of sections, and deduct the amount of ceiling to board up one side.

BILL OF MATERIALS FOR MODEL POULTRY HOUSE.

ONE SECTION ONLY, 24′x16′.

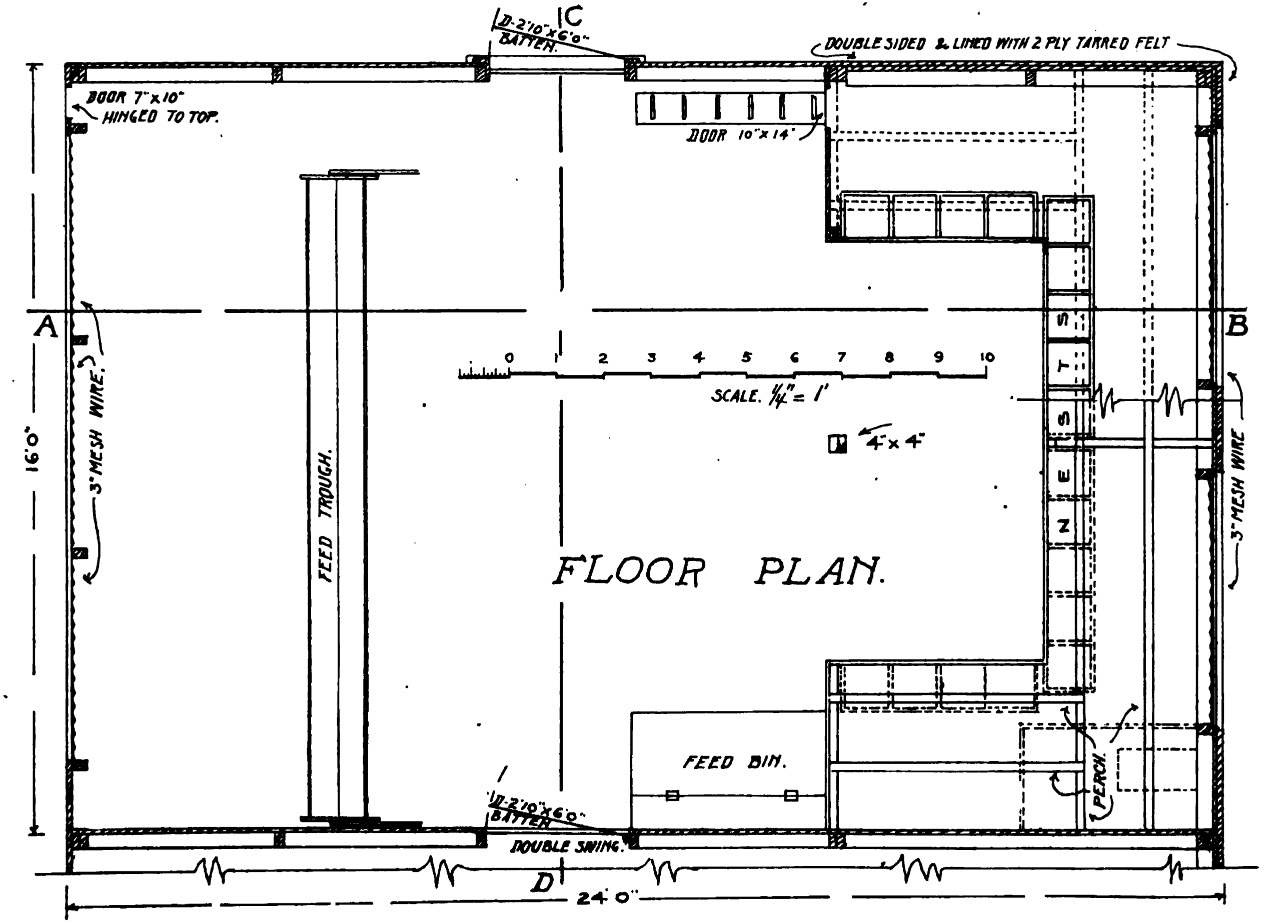
6 pcs. posts, 6″x2′ 6″ locust.
3 pcs. posts, 6″x3′ 6″ locust.
3 pcs. posts, 6″x4′ 6″ locust.
11 pcs. joist, 2″x8″—16′ 0″ long, hemlock.
11 pcs. joist, 2″x8″— 8′ 0″ long, hemlock.
9 pcs. sills, girders, etc., 2″x8″—16′ 0″ long, hemlock.
14 pcs. plates and joist bearers, 2″x4″—16′ 0″ long, hemlock.
40 pcs. studding, etc., 2″x4″—12′ 0″ long, hemlock.
9 pcs. rafters, 2″x6″—18′ 0″ long, hemlock.
9 pcs. rafters, 2″x4″—10′ 0″ long, hemlock.
50 ft. b. m. patent siding, 5″ face, poplar.
700 ft. b. m. shiplap, 5″ face, poplar.

600 ft. b. m. roof sheathing, 4″ common No. 2 y. p. flooring.
350 ft. b. m. double surfaced y. p. ceiling, ⅞″x4″ No. 2 com.
600 ft. b. m. flooring, matched y. p. 3½″ face, No. 2.
75 ft. b. m. ceiling, ⅝″x3″ matched and bearded, y. p. No. 2.
2 pcs. ⅞″x10″—16′ 0″ long, S-4-S, poplar, feed trough.
1 pcs. ⅞″x 4″—16′ 0″ long, S-4-S, poplar, feed trough.
1 pcs. ⅞″x 7″—16′ 0″ long, S-4-S,poplar, nests.
4 pcs. ⅞″x 5″—10′ 0″ long, S-4-S,poplar, nests.
1 pcs. ⅞″x 8″—12′ 0″ long, S-4-S, poplar, gangs.
2 pcs. ⅞″x 5″—12′ 0″ long, S-4-S, poplar, gangs.
1 door frame, 2′ 10″x6′ 0″—½″x1¾″ rebate strip, poplar.
1 door frame, 2′ 8″x4′ 0″—½″x1¾″ rebate strip, poplar.
1 door frame, 2′ 11½″x6′ 5″—fitted with 1½″x1½″ hinge strip for double-acting door, poplar.
2 doors, 2′ 10″x6′ 0″—⅞ double surfaced, matched and beaded batten doors with ⅞″x4″ battens, poplar.
1 door, 2′ 8″x4′ 0″—⅞″ double surfaced, matched and beaded batten door with ⅞″x4″ battens, poplar.
1 mullion window frame, 2 single sash, 6 lt. 10″x12″, poplar.
2 sash, 1⅜″—6 lt. 10″x12″, glazed S. S. A. glass.
5 squares composition tarred felt roofing, 2 ply, first quality.
2 squares tarred building felt, 2 ply.
14 lin, ft. mesh wire, 3″ sq. mesh. 50″ wide, No. 20. wire.
14 lin, ft. mesh wire, 3″ sq. mesh. 32″ wide, No. 20. wire.

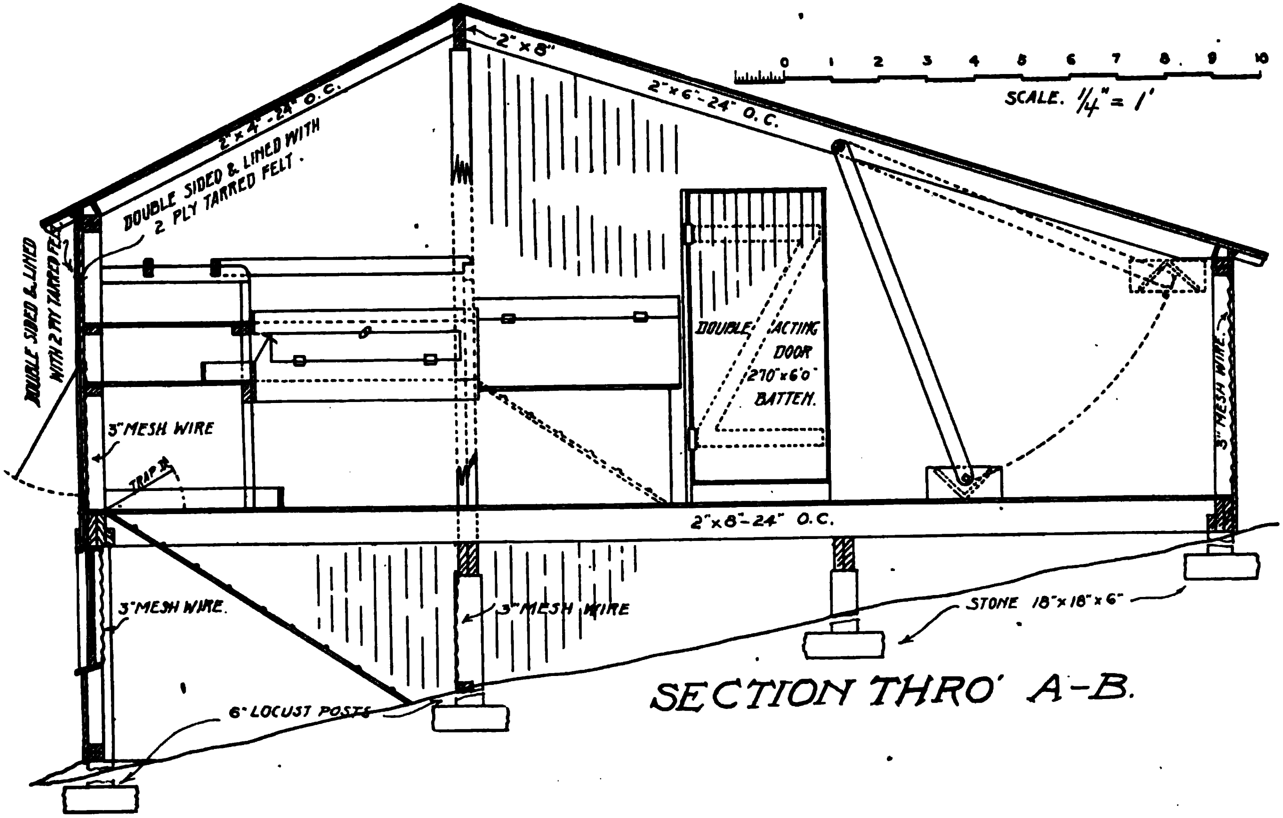


FOUNDATION PLAN.

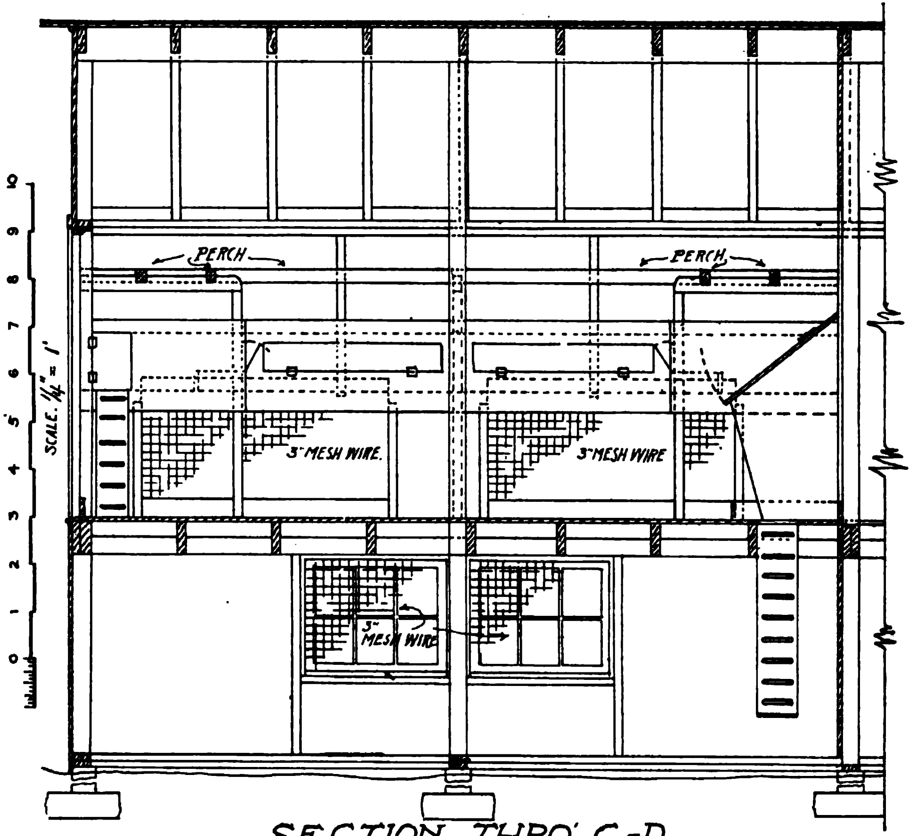
NOTE:
ALL POSTS SET ON 18"x18"x6" STONE.
ALL POSTS 6" LOCUST.
SEE SECTIONS.


FLOOR PLAN.

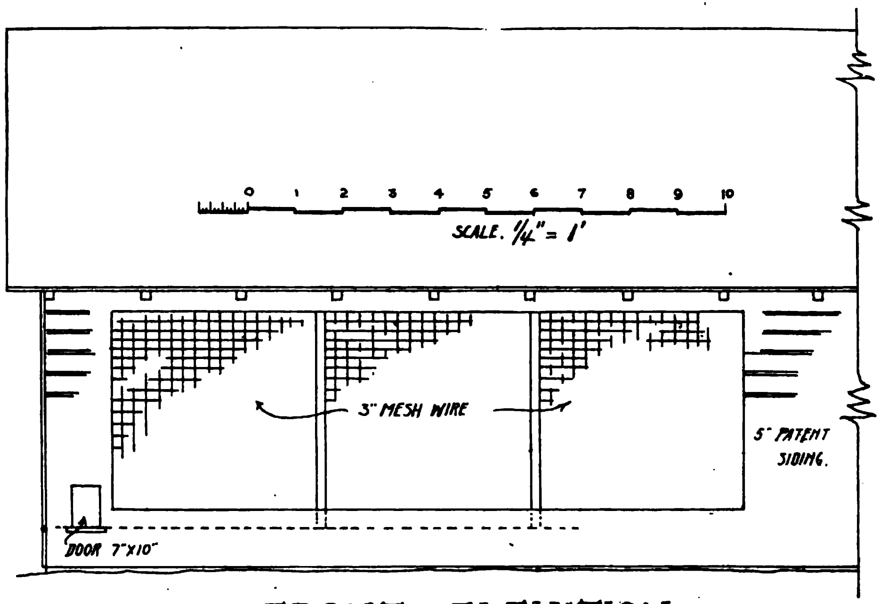
C
D-2'10"x6'0" BATTEN.
DOUBLE SIDED & LINED WITH 2 PLY TARRED FELT
DOOR 7"x10" HINGED TO TOP.
DOOR 10"x14"
A
B
3" MESH WIRE.
3" MESH WIRE
16'0"
FEED TROUGH.
0 1 2 3 4 5 6 7 8 9 10
SCALE. 1/4" = 1'
4"x4"
N E S T S
FEED BIN.
PERCH.
D-2'10"x6'0" BATTEN
DOUBLE SWING.
D
24'0"



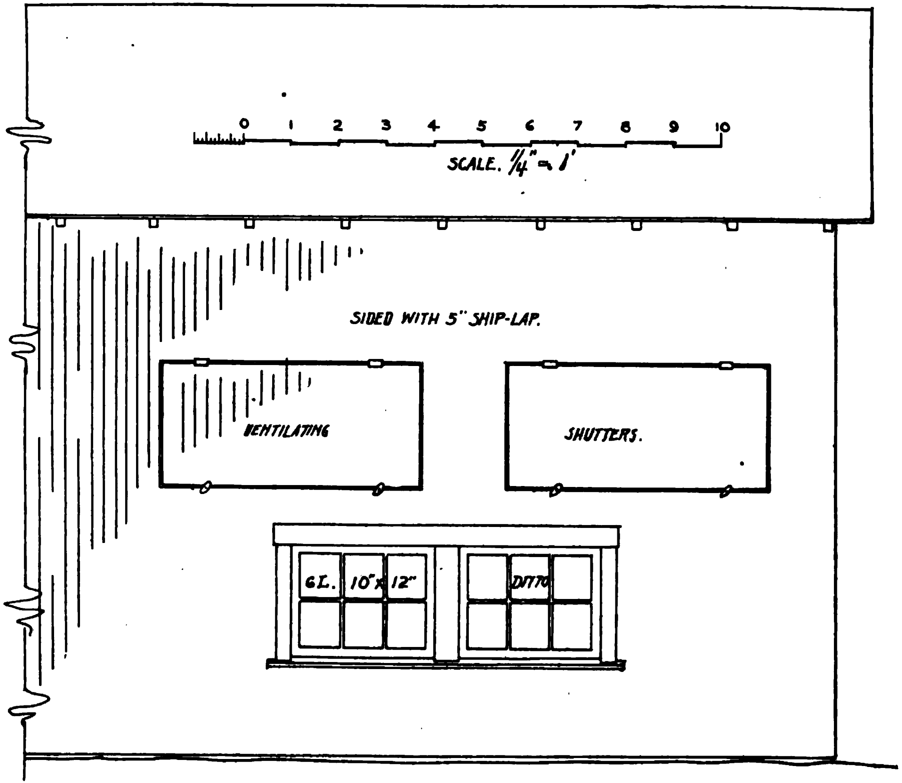
SECTION THRO' A-B.



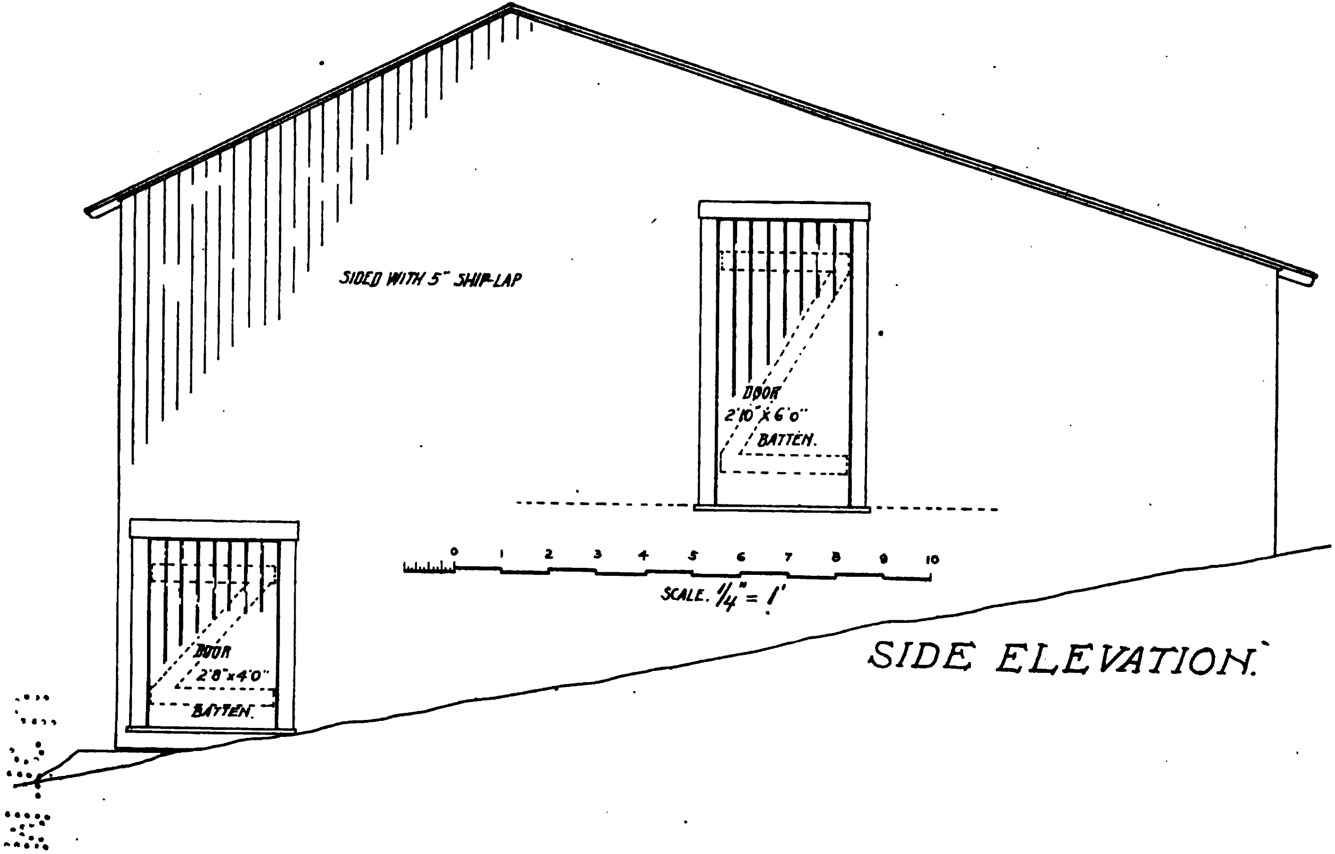
SECTION THRO' C-D.



FRONT ELEVATION



REAR ELEVATION



SIDE ELEVATION.

630.679
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OF MICHIGAN

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 131. NOVEMBER, 1910.

Plat Experiments with Fertilizers

BY J. H. STEWART AND HORACE ATWOOD.

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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Experiments with Fertilizers

In 1900 an experiment was started to determine the fertilizer requirements of the soil of the Experiment Station Farm. This experiment has been continued without interruption, and without changing the original plan. Two bulletins, Nos. 99, and 112 discussing the results of this experiment have been published, and the present bulletin brings the results down to date. As the supply of both of the bulletins mentioned has been exhausted the present publication covers the results of the entire investigation.

The plats used in this experiment are one-tenth of an acre in size, and the same fertilizer has been applied to the same plat year after year and the crop rotated.

Soils differ remarkably in respect to their fertilizer requirements, and it is fortunate that the soil of the Experiment Station farm, where these experiments have been carried on, is typical of a large part of the upland soil of the state. Geologically considered it is a Permeo-Carboniferous soil, and has been formed through the decomposition and disintegration of the strata of rocks which form the protective covering of the Pittsburg vein of coal. Consequently it is a lightish soil, of a sandy texture, easily tilled, but which dries out too rapidly in summer. The original timber consisted of oaks, poplars and chestnuts, together with an occasional locust, maple and beech.

In practical agriculture the fertility of the soil is of the first importance, for if the soil is so poor that satisfactory yields cannot be obtained then the difference between the cost of producing a crop and its market value may be so small that no adequate profit remains, while if a crop is sufficiently large then the cost of production tends to become relatively smaller, and the profits larger.

It is of course important to select crops adapted to the soil and climate and which have either directly or indirectly a high market value. It is important to select the right variety; to plant good seed in a well prepared seed bed and to give the crop thorough and intelligent cultivation, yet even if these things are all properly done and the soil is so poor that a small yield is obtained then there remains little or no profit to repay the husbandman for his efforts.

The fertility of the soil depends upon and is influenced by many complex factors. The physical condition of the soil; its water-holding capacity; the amount and availability of the different essential plant food materials; the presence or absence of injurious substances or organisms, each and all have their influence in affecting productivity and all are important. Plants cannot grow, however, unless they have food, and other things being equal the luxuriance of growth depends, not upon the total amount of available plant food present in the soil and atmosphere, but upon that particular food material which is present in the smallest amount relative to the needs of the crop. For example, if only enough potash in an acre of soil becomes available in one season for the production of one thousand pounds of hay per acre, then only one thousand pounds of hay per acre will be produced, even though there is present enough available phosphoric acid, lime, nitrogen, iron, sulphur, magnesia and silica for the production of five tons of hay per acre.

In order to select and use commercial fertilizers or stable manure intelligently it is necessary to know what plant food is especially lacking in the soil to which the fertilizer is to be applied. When this is known a fertilizer can be selected which is rich in the deficient element, or if stable manure is used, and it is not sufficiently rich in the deficient element, then a commercial fertilizer can be used in connection with the stable manure so as to properly "balance" the application, and thus materially increase its effectiveness.

Unfortunately, many soils are not fertile. They are either poor by nature or have been impoverished by improper management. The result in either case is the same. The crops are too small. How are the yields to be increased? Farmers in the Eastern States are relying upon the use of commercial fertilizers for this purpose. In West Virginia alone the value of the commercial fertilizer used amounts to about a million dollars annually, and if this large sum of money is to be spent each year by the farmers of this State for the purpose of securing better crops it is quite needless to say that these fertilizers should be used so as to produce the utmost possible increase in the yields of the crops for which they are applied. The experiments described in this bulletin have been performed so as to throw some light on this subject.

In order to avoid the effect of any possible inequality in the original fertility of the plats every third plat of the series was left unfertilized, and in discussing the results the yields of each fertilized plat has been compared with the average yield of the two nearest unfertilized ones. By this method of comparison the minor differences in the natural fertility of the plats is almost wholly eliminated.

CROPS GROWN.

The crops in this test have been as follows: Iu 1900 rye was grown; in 1901 wheat; in 1902 clover; in 1903 corn; in 1904 cow-peas; in 1905 corn; in 1906 potatoes; in 1907 rye; in 1908 there was no crop harvested; in 1909 and 1910 hay.

FERTILIZERS USED.

The first application of fertilizer was made in the spring of 1900 as a top-dressing on rye. Later applications have been made with a fertilizer drill, the fertilizers being applied immediately before planting the seed. In 1902 for the crop of clover, in 1907 for the crop of rye, and in 1908 when the plats were seeded to timothy and clover no fertilizer was applied to any of the plats. The first year the carrier of phosphoric acid was Thomas slag, since then acid phosphate has been used.

The following table shows the amount and kind of fertilizer applied annually to each plat, without referring to the exceptions as noted above.

Plat 19. 40 pounds sodium nitrate; 40 pounds acid phosphate; 15 pounds potassium sulphate (20 pounds in 1906); 100 pounds lime in 1900 and 150 pounds lime in 1906.

Plat 20. Two tons stable manure; 100 pounds lime in 1900; 150 pounds lime in 1906.

Plat 21. No fertilizer.

Plat 22. 100 pounds lime in 1900 and in 1903, and 150 pounds in 1906.

Plat. 23. Ash from two tons of stable manure, together with an amount of nitrogen in the form of sodium nitrate equivalent to the nitrogen originally present in the stable manure. Applications made in 1900 and in 1901. Since then no further application.

Plat 24. No fertilizer.

Plat 25. Two tons stable manure applied annually except in 1902, 1903 and 1907.

Plat 26. 40 pounds sodium nitrate; 40 pounds acid phosphate; 15 pounds potassium sulphate (20 pounds in 1906).

Plat 27. No fertilizer.

Plat 28. 40 pounds acid phosphate; 15 pounds potassium sulphate (20 pounds in 1906).

Plat 29. 40 pounds sodium nitrate; 15 pounds potassium sulphate (20 pounds in 1906).

Plat 30. No fertilizer.

Plat 31. 40 pounds acid phosphate; 40 pounds sodium nitrate.

Plat 32. 15 pounds potassium sulphate (20 pounds in 1906).

Plat 33. No fertilizer.

Plat 34. 40 pounds acid phosphate.

Plat 35. 40 pounds sodium nitrate.

Plat 36. No fertilizer.

RESULTS OBTAINED DURING THE FIRST YEAR OF THE TEST.

In the spring of 1900 a field which had been sown to rye in the fall of 1899, and fertilized at the rate of 400 pounds of complete fertilizer per acre, was selected for this experiment and divided into plats each one-tenth of an acre in size, two rods wide and eight rods long, with an alley four feet wide extending between them. The plats were sown to clover on the 7th of March and the different fertilizers were applied as a top-dressing on the succeeding day.

Table showing the yield of rye from the different plats:

Plat	Fertilizer.	Pounds straw per acre	Pounds grain per acre	Ratio of grain to straw
13	No fert.	2117	1153	1 to 1.83
14	" "	2470	1220	1 to 2.00
15	" "	2318	1182	1 to 1.96
16	" "	2501	1239	1 to 2.01
17	" "	2263	1067	1 to 2.12
18	" "	2385	1215	1 to 1.96
19	N,K_2O,P_2O_5,CaO	3524	2076	1 to 1.69
20	Manure, Lime	2762	1578	1 to 1.75
21	No fert.	2064	1186	1 to 1.74
22	Lime	1813	1077	1 to 1.68
23	Ash, N.	3845	2095	1 to 1.83
24	No fert.	2070	1100	1 to 1.88
25	Manure	3587	1913	1 to 1.87
26	N,K_2O, P_2O_5	4317	2463	1 to 1.75
27	No fert.	2583	1297	1 to 1.99
28	P_2O_5,K_2O	2739	1411	1 to 1.94
29	N, K_2O	3560	1980	1 to 1.79
30	No fert.	2540	1340	1 to 1.89
31	N, P_2O_5	4153	2267	1 to 1.83
32	K_2O	2678	1402	1 to 1.91
33	No fert.	2600	1330	1 to 1.95
34	P_2O_5	2810	1360	1 to 2.06
35	N.	3716	1914	1 to 1.94
36	No fert.	2380	1220	1 to 1.95

The average yield per acre of the twelve plats which received no fertilizer was 2,357 pounds of straw and 1,212 pounds of grain, while the average of the remaining twelve plats which received different applications of plant food was 3,292 pounds of straw and 1,794 pounds of grain, leaving a balance in favor of the fertilizers of 935 pounds of straw and 582 pounds of grain. It may be repeated here that when the rye was sown the entire field in which the plats are situated received an application of 400 pounds of complete fertilizer per acre, and yet in spite of this somewhat liberal application the various top-dressings applied in the spring gave an average increase of over ten bushels of grain per acre.

In the following table the yield of each fertilized plat is compared with the average yield of the two nearest plats which were not fertilized in the spring of 1900. By this method of comparison the minor differences in the natural fertility of the plats are almost wholly eliminated.

			Straw.	Grain.
Plat 19	Excess over average of	18 and 21	1300	876
Plat 20	" " "	18 and 21	538	378
Plat 22	Decrease from "	21 and 24	254	66
Plat 23	Excess over "	21 and 24	1778	952
Plat 25	" " "	24 and 27	1261	715
Plat 26	" " "	24 and 27	1991	1265
Plat 28	" " "	27 and 30	178	93
Plat 29	" " "	27 and 30	999	662
Plat 31	" " "	30 and 33	1583	932
Plat 32	" " "	30 and 33	108	67
Plat 34	" " "	33 and 36	320	85
Plat 35	" " "	33 and 36	1226	639

SUMMARY FOR THE FIRST YEAR.

Remembering that the different fertilizers were applied as a top-dressing in the spring, the following observations may be made concerning the first year of the test:

1. The table shows that sodium nitrate when applied alone or in combination with potash or phosphoric acid, materially increased the yield of both grain and straw.

2. Thomas slag when used alone, or with potash, increased the yield but slightly, but when employed with nitrogen was of considerable value.

3. Potassium sulphate when used alone, or combined with either nitrogen or phosphoric acid, was apparently of little benefit.

4. The largest yield was obtained when the three elements, nitrogen, potash, and phosphoric acid were employed, the increase over the average of the two unfertilized plats being 22.5 bushels of grain per acre.

5. The stable manure increased the yield of both grain and straw, acting somewhat more favorably than an application of nitrogen.

6. The ash of stable manure with nitrogen added gave a larger yield than manure alone.

7. Lime when used alone, or in combination with stable manure, or with nitrogen, potash and phosphoric acid, acted injuriously.

RESULTS OBTAINED DURING THE SECOND YEAR OF THE TEST.

The stand of clover upon some of the plats not being satisfactory all of the plats were plowed and prepared for wheat, which was sown October 6, 1900. At the time of sowing the soil was very dry, but rain came on the 7th and 8th of the month, and the wheat promptly came up and made a fairly good growth before winter began.

The same kind and amount of the different fertilizers was applied to the different plats as in the preceding year except that acid phosphate was substituted for Thomas slag, and no more lime was applied to plats 19, 20 and 22. The fertilizers were applied broadcast before the wheat was sown. The acid phosphate employed had the following composition:

Available phosphoric acid	15.74%
Total phosphoric acid	16.30%

The variety of wheat used was the Valley, obtained from the Ohio Experiment Station. It was harvested July 3rd and threshed from the shock shortly after. All of the plats were again seeded to clover on the 18th of March, resulting in a good stand.

The following tables give the results of the test in 1901:

Table showing the yield of wheat from the different plats:

Plat	Fertilizer.	Pounds straw per acre	Pounds grain per acre	Ratio of grain to straw
19	"Complete" fert.	(Lodged severely and not weighed.)		
20	Stable Manure	4560	1840	1 to 2.47
21	No fert.	1160	1140	1 to 1.11
22	Lime in 1900	1490	1010	1 to 1.47
23	Ash and N	3320	1880	1 to 1.76
24	No fert.	1830	1070	1 to 1.71
25	Stable Manure	4580	1920	1 to 2.38
26	N,K_2O,P_2O_5	3950	1750	1 to 2.25
27	No fert.	1780	1120	1 to 1.58
28	P_2O_5,K_2O	3350	1550	1 to 2.16
29	N, K_2O.	1820	1080	1 to 1.68
30	No fert.	1650	1050	1 to 1.57
31	N, P_2O_5	3550	1550	1 to 2.29
32	K_2O	1670	1030	1 to 1.62
33	No fert.	1990	1110	1 to 1.79
34	P_2O_5	2610	1390	1 to 1.87
35	N.	1770	930	1 to 1.90
36	No fert.	1250	750	1 to 1.66

The average yield of the six plats which were not fertilized was 1610 pounds of straw and 1040 pounds of grain per acre, while the average of the remaining eleven plats was 2970 pounds of straw and 1448 pounds of grain per acre, leaving a balance in favor of the fertilizers of 1360 pounds of straw and 408 pounds of grain per acre.

In the following table the yield of each fertilized plat is compared with the average yield of the two nearest plats which have not been fertilized, thus bringing out more clearly the influence of the different fertilizers:

Plat.				Straw.	Grain.	
20	Excess over		21	3400	700	
22	Decrease from	average of	21 and 24	5	95	
23	Excess over	"	21 and 24	1825	775	
25	" "	"	24 and 27	2775	825	
26	" "	"	24 and 27	2145	665	
28	" "	"	27 and 30	1635	465	
29	" "	"	27 and 30	105	5	(decrease)
31	" "	"	30 and 33	1730	470	
32	Decrease from	"	30 and 33	150	50	
34	Excess over	"	33 and 36	990	460	
35	" "	"	33 and 36	150	0	

OBSERVATIONS CONCERNING THESE RESULTS.

1. Sodium nitrate when used alone slightly increased the amount of straw but did not increase the yield of grain.

2. Acid phosphate when used alone increased the amount of straw nearly one thousand pounds, and the yield of grain slightly more than seven and one-half bushels per acre.

3. Potassium sulphate when used alone decreased both the yield of straw and grain.

4. Sodium nitrate when used with acid phosphate materially increased the yield of straw, and slightly increased the yield of grain, when compared with the plat on which acid phosphate was applied alone.

5. Sodium nitrate when used with potassium sulphate slightly increased the yield of straw, but decreased the yield of grain when compared with the two nearest unfertilized plats.

6. Potassium sulphate when applied with acid phosphate materially increased the yield of straw and slightly increased the yield of grain when compared with the plat to which acid phosphate was applied alone.

7. Sodium nitrate and potassium sulphate when used with acid phosphate gave a larger increase of both grain and straw than when they were individually applied with acid phosphate.

8. A comparison of the preceding observations clearly shows that for wheat phosphoric acid is decidedly deficient in this soil, and that as soon as this deficiency is overcome then there is a lack of both potash and nitrogen.

9. Stable manure gave a larger increase in the yield of grain than any other fertilizer or combination of fertilizers.

10. The ash of stable manure with an equivalent amount of nitrogen applied in the form of sodium nitrate did not give as large an increase as stable manure alone.

11. The plat to which lime was applied alone in 1900 did not give as large a yield as the average of the two adjoining unfertilized plats; when applied in connection with stable manure, however, the yield of straw was larger than on any of the other plats, and undoubtedly the yield of grain would have been larger if the wheat upon this plat had not lodged severely before the heads were filled.

RESULTS OBTAINED DURING THE THIRD YEAR OF THE TEST.

The clover on plats 19 to 36 inclusive was not fertilized, as it was desirable to study the after-effect of the previous manurings. Plats 13 to 18 inclusive, which had received no fertilizer since the beginning of the test, received applications of potassium sulphate and the double sulphate of potash and magnesia. The application of these manures was made in order to study the effect of an excessive amount of magnesia in the soil, as it has been claimed that too much magnesia in the soil, especially when there is a deficiency of lime, is very deleterious. The potassium sulphate used contained 48.90% potash and the double sulphate of potash and magnesia 24.40% potash and 11.42% magnesia. These fertilizers were applied as a top dressing on April 7th so as to supply 100 pounds of potash per acre to the plats as follows:

Plat	13	Potassium	sulphate.
"	14	"	magnesium sulphate.
"	15	"	sulphate.
"	16	"	magnesium sulphate.
"	17	"	sulphate.
"	18	"	magnesium sulphate.

The first crop of clover was cut June 23rd and the second crop August 20th. The following table shows the total yield of field cured hay from each plat. The hay when weighed was not cured quite as much as was desirable, but it was dry enough so that it kept well in the mow.

Plat 13	2100	pounds of hay per acre. Both crops.
Plat 14	2400	“ “ “ “ “ “ “
Plat 15	2600	“ “ “ “ “ “ “
Plat 16	2750	“ “ “ “ “ “ “
Plat 17	2500	“ “ “ “ “ “ “
Plat 18	2800	“ “ “ “ “ “ “
Plat 19	6700	“ “ “ “ “ “ “
Plat 20	8850	“ “ “ “ “ “ “
Plat 21	2050	“ “ “ “ “ “ “
Plat 22	1500	“ “ “ “ “ “ “
Plat 23	7900	“ “ “ “ “ “ “
Plat 24	2100	“ “ “ “ “ “ “
Plat 25	9550	“ “ “ “ “ “ “
Plat 26	7250	“ “ “ “ “ “ “
Plat 27	2850	“ “ “ “ “ “ “
Plat 28	5500	“ “ “ “ “ “ “
Plat 29	2000	“ “ “ “ “ “ “
Plat 30	2650	“ “ “ “ “ “ “
Plat 31	7900	“ “ “ “ “ “ “
Plat 32	2500	“ “ “ “ “ “ “
Plat 33	2200	“ “ “ “ “ “ “
Plat 34	5400	“ “ “ “ “ “ “
Plat 35	2600	“ “ “ “ “ “ “

The clover showed no bad effect from the application of the double sulphate of potash and magnesia. The average yield of the three plats to which potassium sulphate was applied was 2400 pounds of hay per acre, while the average yield of the three plats receiving potassium magnesium sulphate was 2650 pounds per acre. It is possible that some crops are more susceptible to an excess of magnesium than others. It is to be observed, also, that the average yield of these six plats agrees closely with the yield of plat 32, which has received only potassium fertilizers since the beginning of this experiment.

The following table shows the excess, or decrease, in the yield of the remaining plats as compared with the average yield of the two nearest unfertilized ones.

			Lbs. Hay per acre.
Plat 19	Excess over plat	21	4650
Plat 20	" " "	21	6800
Plat 22	Decrease from average of plats	21 and 24	575
Plat 23	Excess over " "	21 and 24	5825
Plat 25	" " " "	24 and 27	7075
Plat 26	" " " "	24 and 27	4775
Plat 28	" " " "	27 and 30	2750
Plat 29	Decrease from " "	27 and 30	750
Plat 31	Excess over " "	30 and 33	5475
Plat 32	" " " "	30 and 33	75
Plat 34	" " " "	33	3200
Plat 35	" " " "	33	400

SUMMARY FOR THE THIRD YEAR.

1. The table shows that former applications of sodium nitrate and potassium sulphate when applied alone did not materially increase the crop of clover, while former applications of phosphoric acid were of decided benefit.

2. Former applications of sodium nitrate and phosphoric acid combined gave a considerably larger excess than phosphoric acid when applied alone, while former applications of a mixture of sodium nitrate and potassium sulphate seem to have acted injuriously.

3. The plat to which phosphoric acid and potash had been applied in combination did not give as large an increase over the average of the two nearest unfertilized plats as the plat to which phosphoric acid was applied alone.

4. The plat which received sodium nitrate, potassium sulphate and phosphoric acid did not give as large an increase over the unfertilized plats as the plat to which only sodium nitrate and phosphoric acid had been applied.

5. It is thus seen that in this test former applications of a mixture of sodium nitrate and potassium sulphate when used either with or without phosphoric acid acted injuriously.

6. The largest increase over the average of the two nearest unfertilized plats was obtained from the plat to which stable manure had been applied, next in order stands the plat which, in addition to stable manure, had received an application of lime.

7. Comparing the excess yields of plats 23 and 25 to the first of which has been applied ash of stable manure and nitrogen, and to the second only stable manure, it is seen that the stable manure plat gave a considerably larger increase.

8. Plat 22, which received an application of lime in 1900 did not yield as well as the average of the two nearest unfertilized plats; also when the excess yields of plats 19 and 20 are compared with the excess yield of plats 26 and 25, respectively, it is seen that the lime has acted injuriously on this particular soil when used either with a complete fertilizer or with stable manure.

9. The average yield per acre of the five plats, 21, 24, 27, 30 and 33, which have received no fertilizers since the beginning of the experiment, was 2370 pounds of hay per acre, while the average yield of the remaining twelve plats which have been fertilized was 5637 pounds per acre, or more than twice as much as the continually unfertilized plats.

RESULTS OBTAINED DURING THE FOURTH YEAR OF THE TEST.

The clover sod was plowed April 21st, 1903, harrowed thoroughly and planted to corn May 16th, an unnamed yellow dent variety being employed. The fertilizers were applied broadcast immediately before planting and harrowed into the soil. No lime was applied to plats 19 and 20, and only one-half of the usual amount of sodium nitrate was applied, immediately before the corn was planted, to plats 19, 26, 28, 29, 31 and 35, the other half being applied June 15th. No more fertilizer was applied to plats 23 and 25, and acid phosphate was substituted for Thomas slag for all plats receiving phosphoric acid. Owing to the difficulty of burning the stable manure and applying the ashes, which are very light and easily blown about by the wind, this portion of the experiment was discontinued. Except as noted the same kind and amount of fertilizer was applied to the plats as in the first year of the test.

The season of 1903 was very unfavorable for the growth of corn. The latter part of May, and the months of June and July were excessively wet while only 2.48 inches of rain fell from the first of August until the 25th of September, when the corn was cut.

The corn was husked October 10th, and the stalks and the corn in the ear weighed at once.

The following tables show the yield of corn and stalks from various plats:

Plat.	Corn.	Forage.	Plat.	Corn.	Forage.
No. 13	180	335	No. 25	523	650
No. 14	197	350	No. 26	562	700
No. 15	158	300	No. 27	198	345
No. 16	153	295	No. 28	516	620
No. 17	174	285	No. 29	150	330
No. 18	195	290	No. 30	182	360
No. 19	620	680	No. 31	540	700
No. 20	770	940	No. 32	200	375
No. 21	200	380	No. 33	193	360
No. 22	162	320	No. 34	457	575
No. 23	441	580	No. 35	133	330
No. 24	177	365	No. 36	150	310

The average yield of plats 13, 15 and 17, which received an application of potassium sulphate in 1902, was 171 pounds of corn and 307 pounds of stalks per plat, while plats 14, 16 and 18, which received potassium magnesium sulphate, gave an average yield of 182 pounds of corn and 312 pounds of stalks per plat. As the difference in the yields is so slight it is probable that the presence of the magnesium salt has influenced the results neither one way nor the other. The slight difference in the

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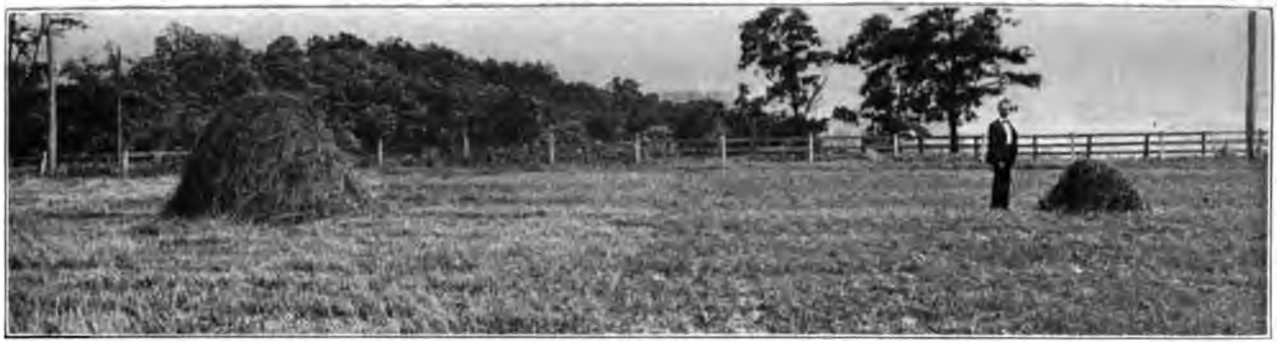
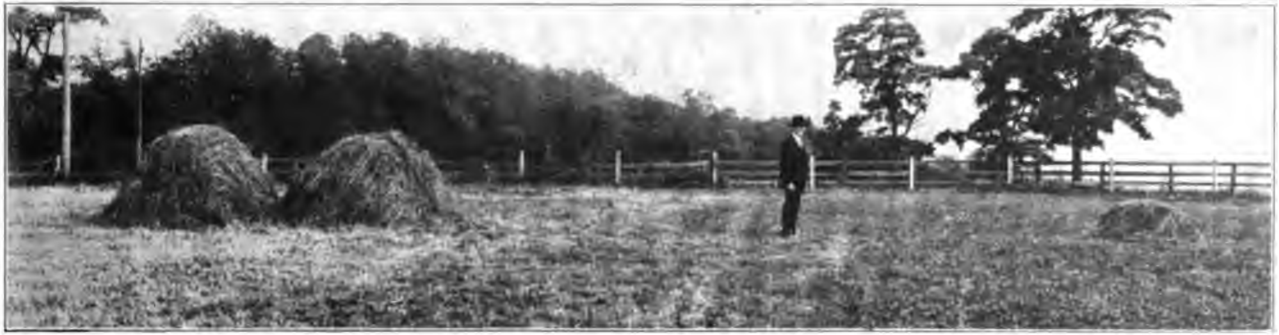


Plat 19.
Nitrogen, Potash, Phosphoric Acid and Lime.

Plat 18.
No Fertilizer.

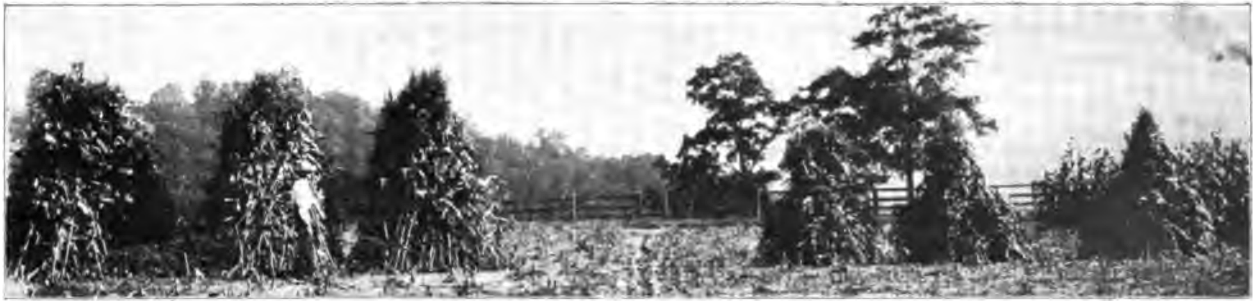
HAY IN 1909.



Plat 19.
Nitrogen, Potash, Phosphoric Acid and Lime.

Plat 18.
No Fertilizer.

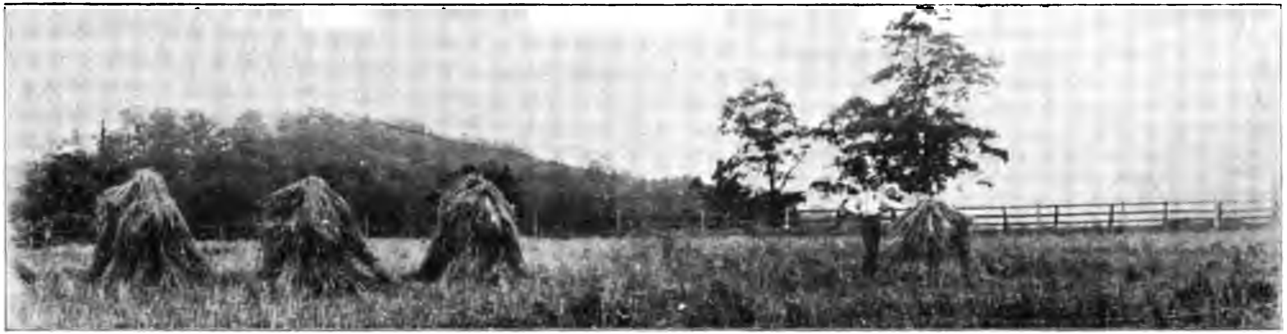
HAY IN 1910.



Plat 19.
Nitrogen, Potash, Phosphoric Acid and Lime.

Plat 18.
No Fertilizer.

CORN IN 1905.



Plat 19.
Nitrogen, Potash, Phosphoric Acid and Lime.

Plat 18.
No Fertilizer.

RYE IN 1907.

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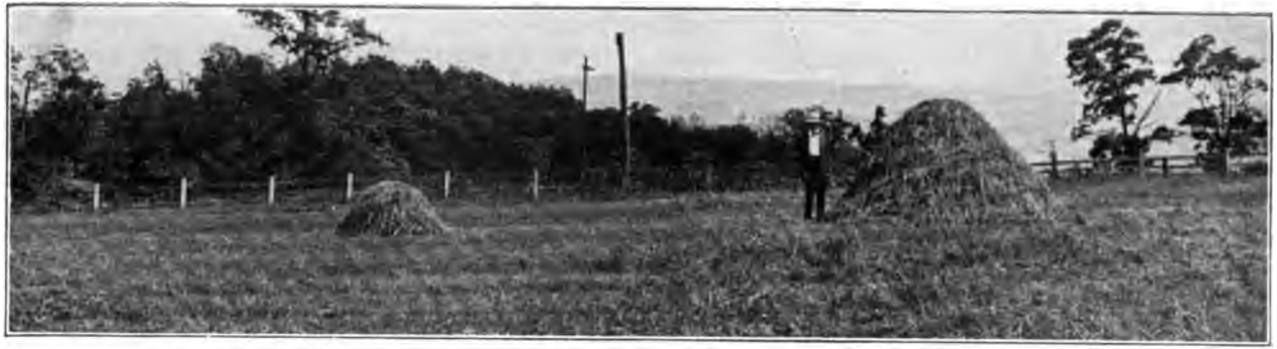
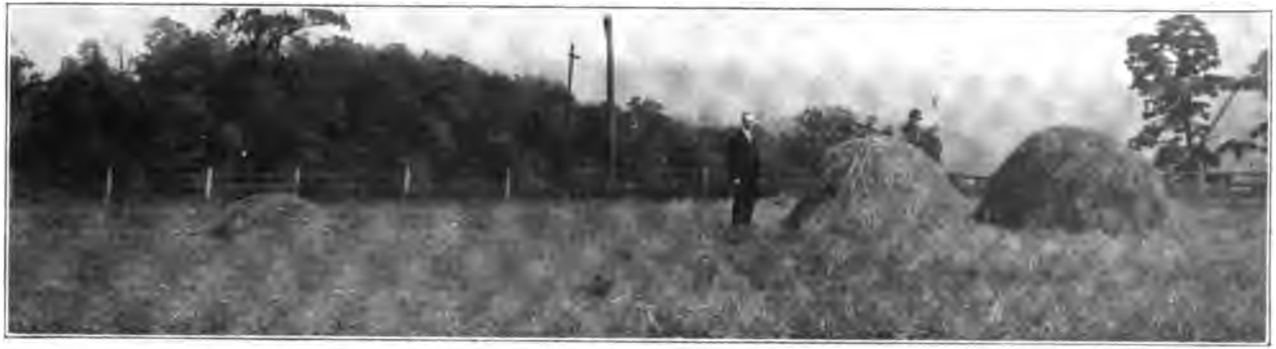


PLAT 21.
NO FERTILIZER.

STABLE MANURE AND LIME.
PLAT 20.

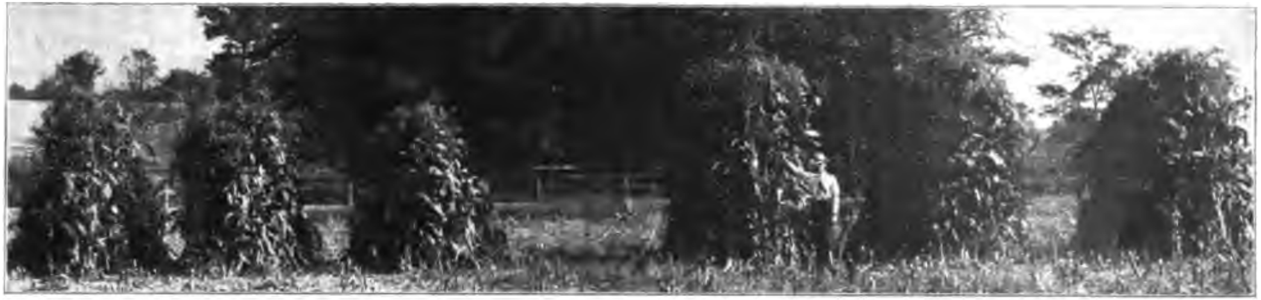
HAY IN 1909.



PLAT 21.
NO FERTILIZER.

PLAT 20.
STABLE MANURE AND LIME.

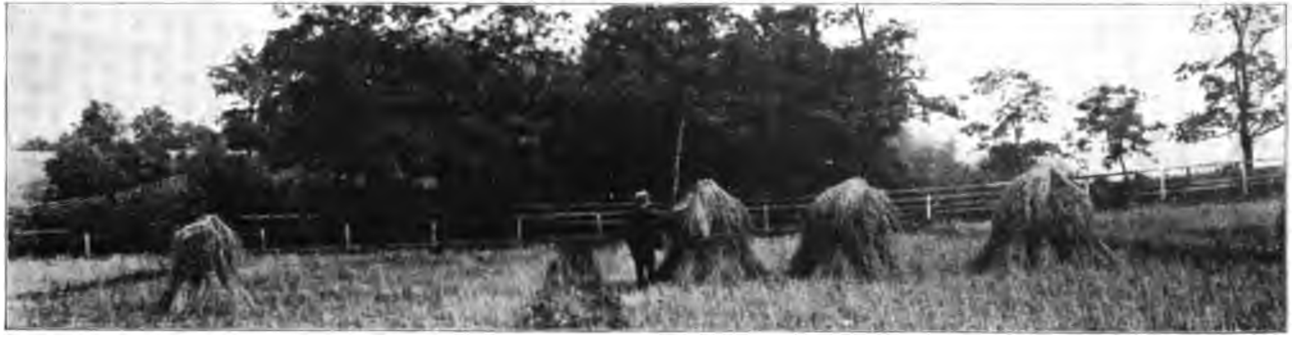
HAY IN 1910.



PLAT 27.
NO FERTILIZER.

PLAT 26.
PHOSPHORIC ACID POTASH AND NITROGEN.

CORN IN 1905.



PLAT 27.
NO FERTILIZER.

PLAT 26.
NITROGEN, POTASH AND PHOSPHORIC ACID.

RYE IN 1907.

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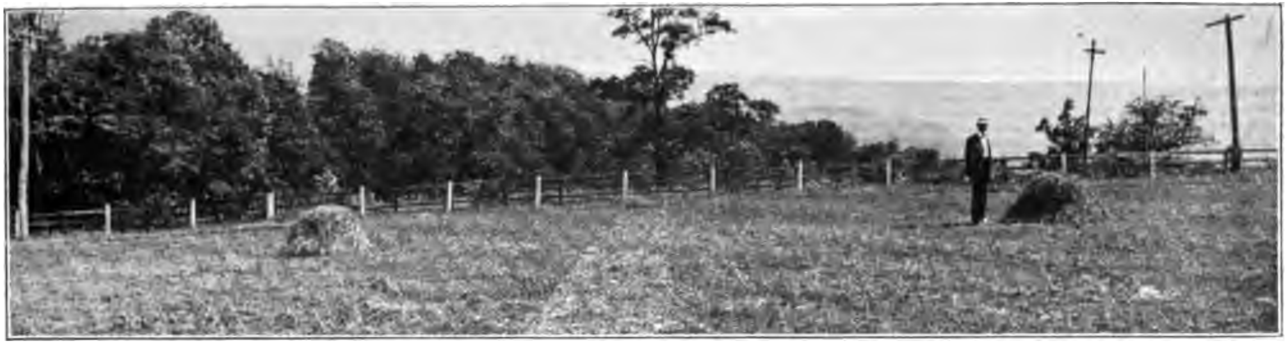
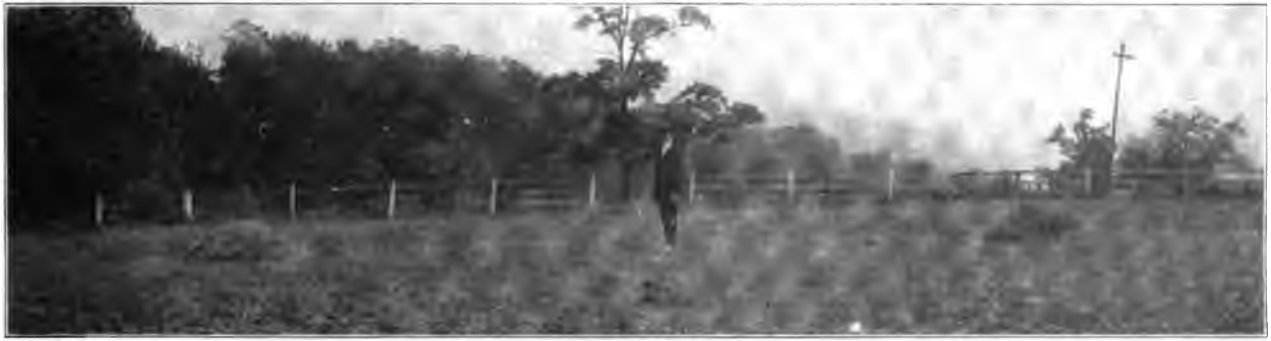


Plat 23.
Ash and Nitrogen.

Plat 22.
Lime.

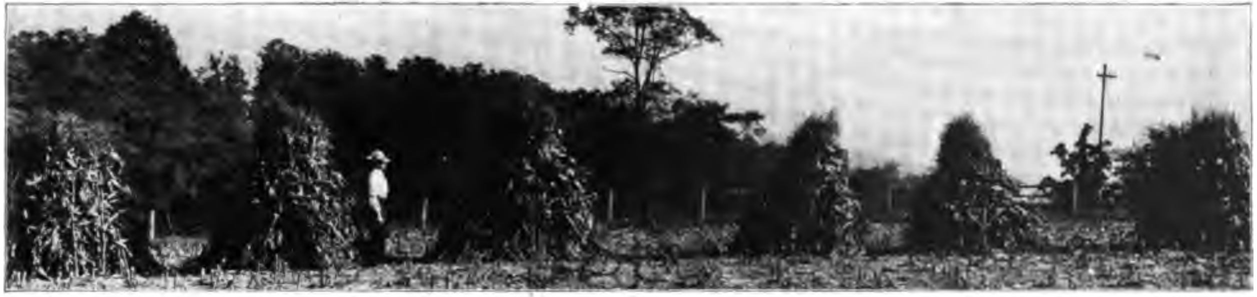
HAY IN 1909.



Plat 23.
Ash and Nitrogen.

Plat 22.
Lime.

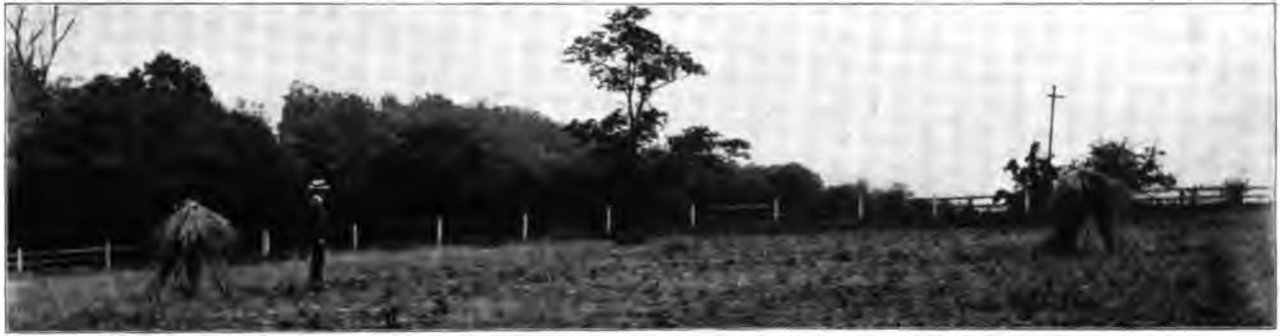
HAY IN 1910.



Plat 23.
Ash of Stable Manure and Nitrogen.

Plat 22.
Lime.

CORN IN 1905.



Plat 23.
Ash and Nitrogen.

Plat 22.
Lime.

RYE IN 1907.

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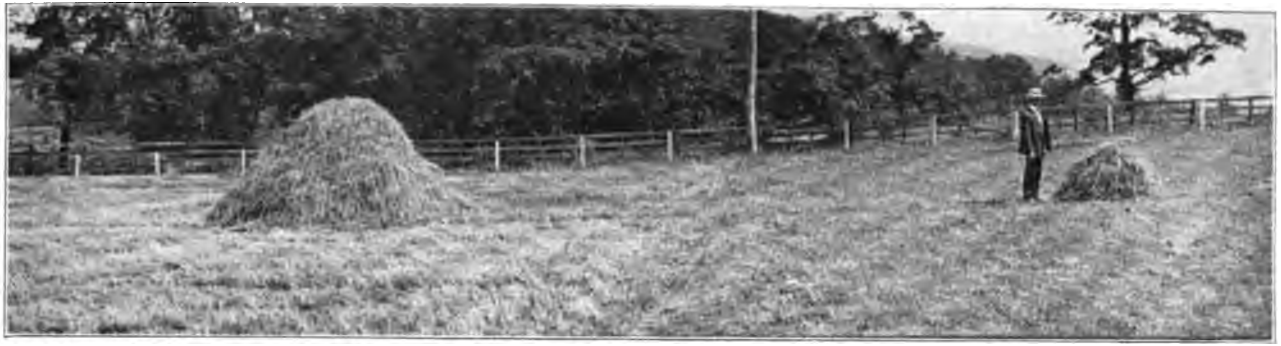
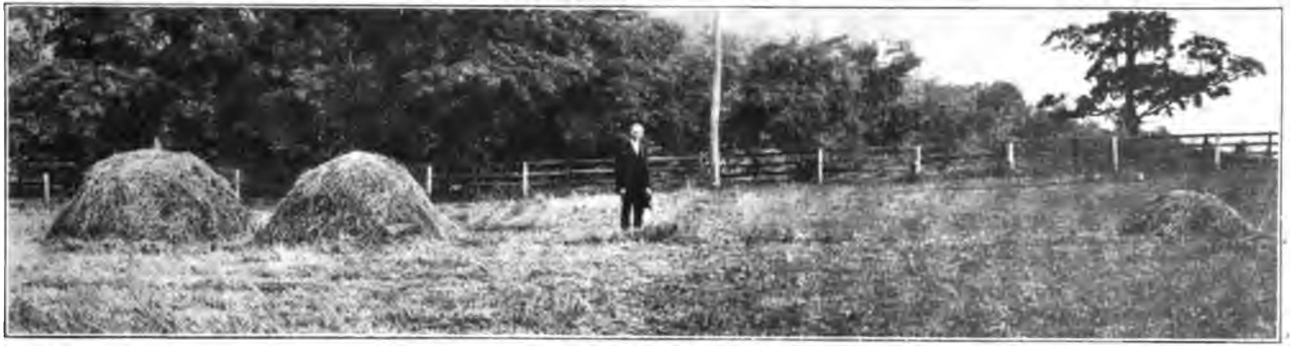


PLAT 25.
STABLE MANURE.

PLAT 24.
NO FERTILIZER.

HAY IN 1909.



PLAT 25.
STABLE MANURE.

PLAT 24.
NO FERTILIZER.

HAY IN 1910.

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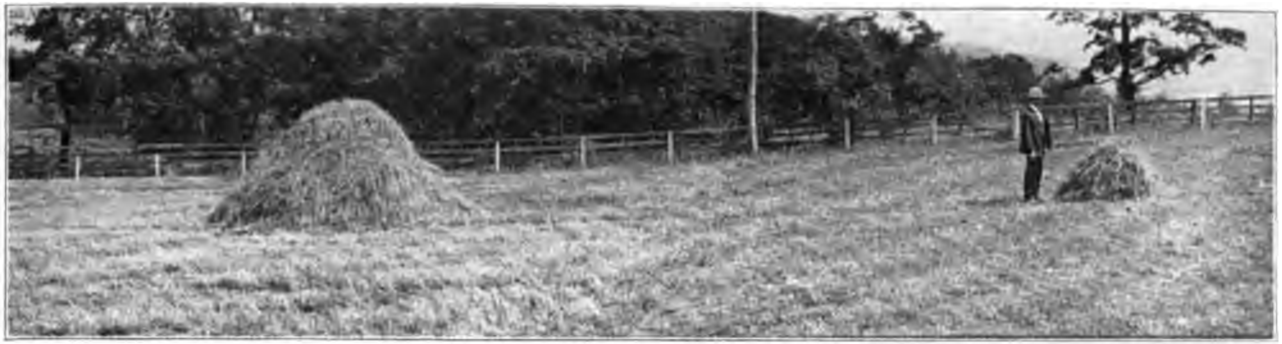
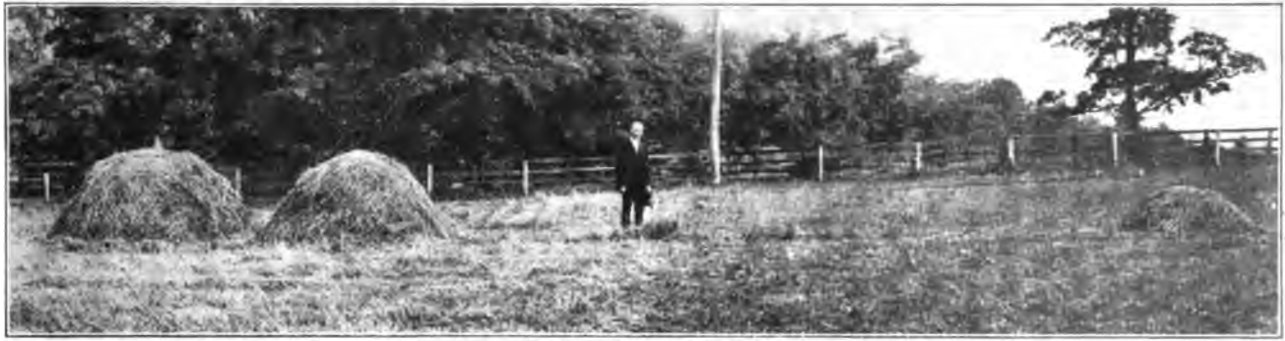


Plat 25.
Stable Manure.

Plat 24.
No Fertilizer.

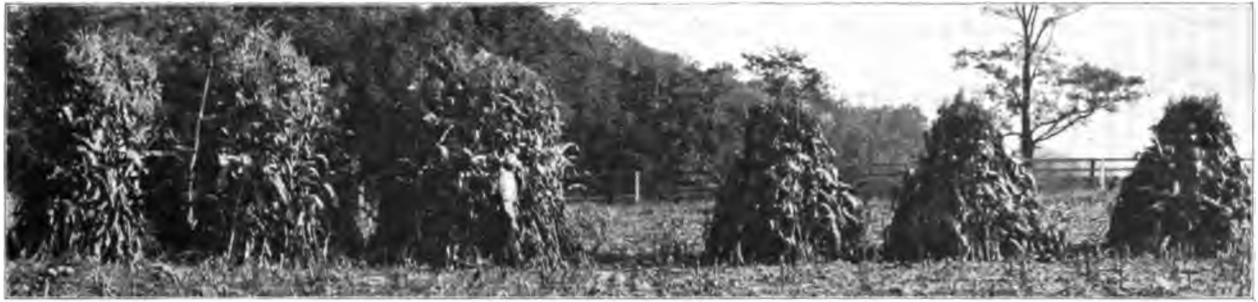
HAY IN 1909.



Plat 25.
Stable Manure.

Plat 24.
No Fertilizer.

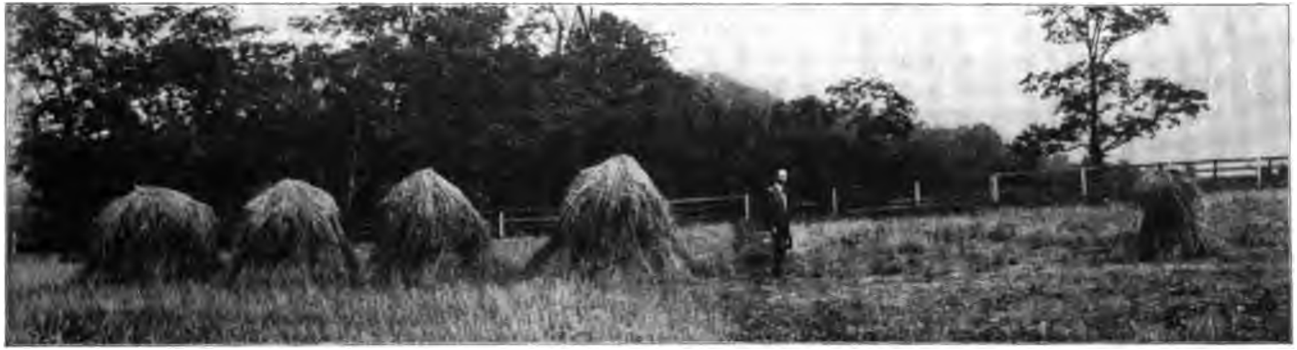
HAY IN 1910.



Plat 25.
Stable Manure.

Plat 24.
No Fertilizer.

CORN IN 1905.



Plat 25.
Stable Manure.

Plat 24.
No Fertilizer.

RYE IN 1907.

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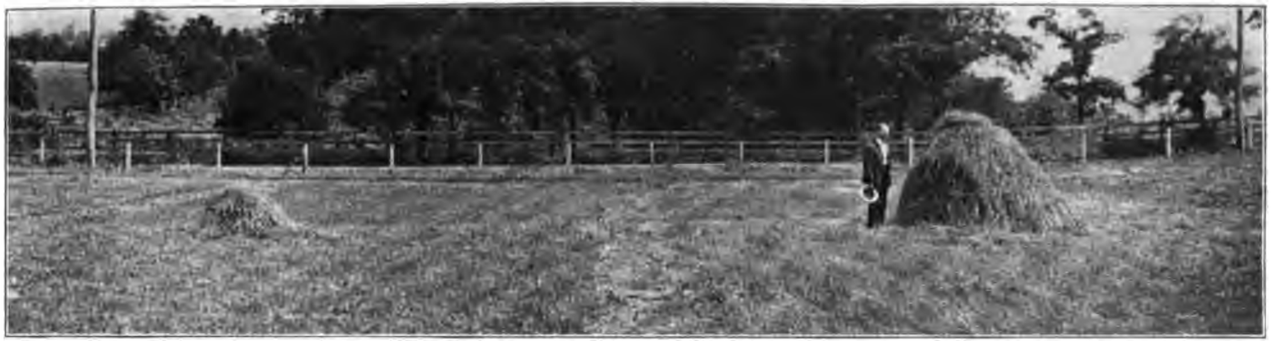
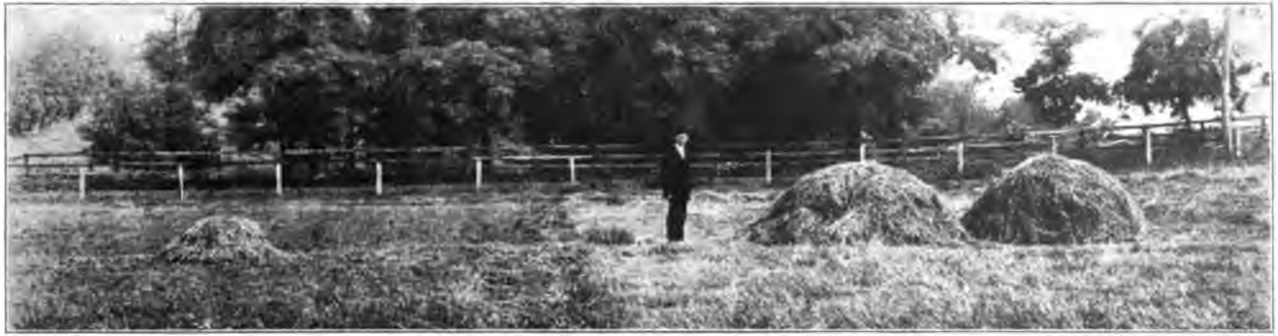


Plat 27.
No Fertilizer.

Plat 26.
Nitrogen, Potash and Phosphoric Acid.

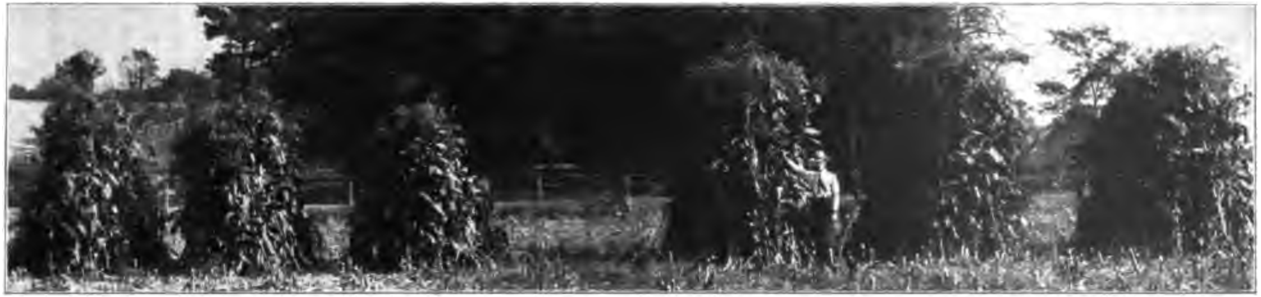
HAY IN 1909.



Plat 27.
No Fertilizer.

Plat 26.
Nitrogen, Potash and Phosphoric Acid.

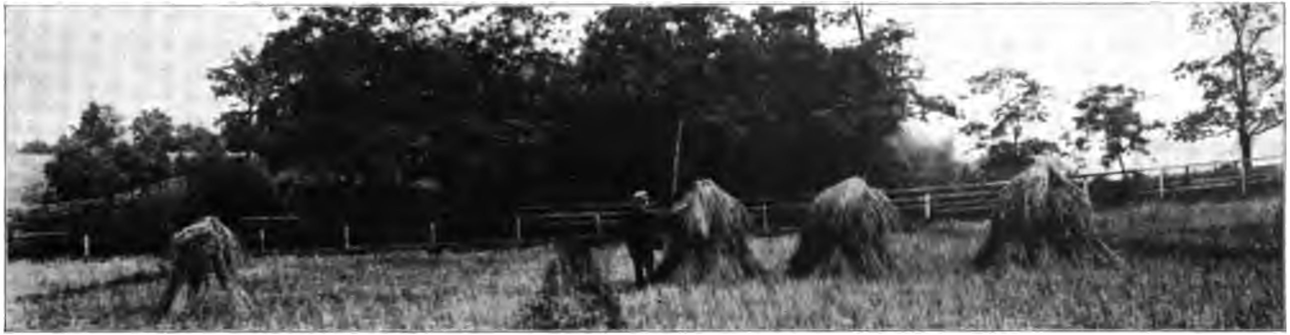
HAY IN 1910.



Plat 27.
No Fertilizer.

Plat 26.
Phosphoric Acid Potash and Nitrogen.

CORN IN 1905.



Plat 27.
No Fertilizer.

Plat 26.
Nitrogen, Potash and Phosphoric Acid.

RYE IN 1907.

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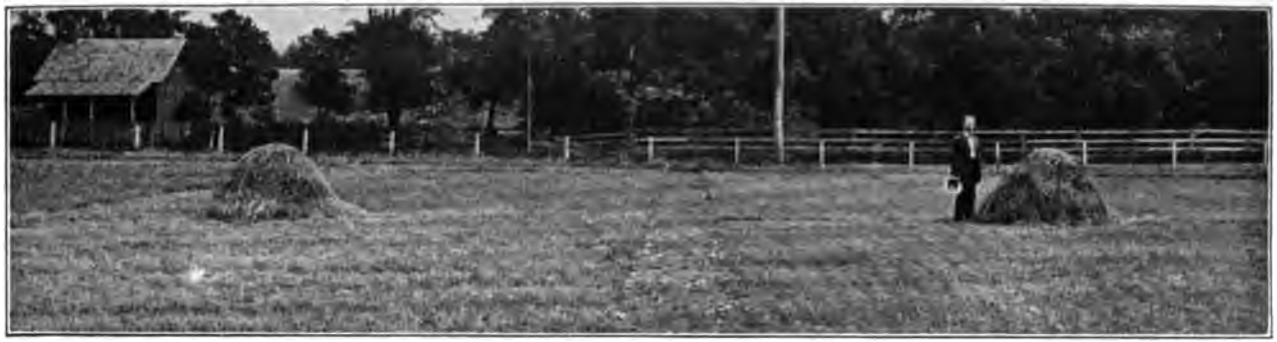
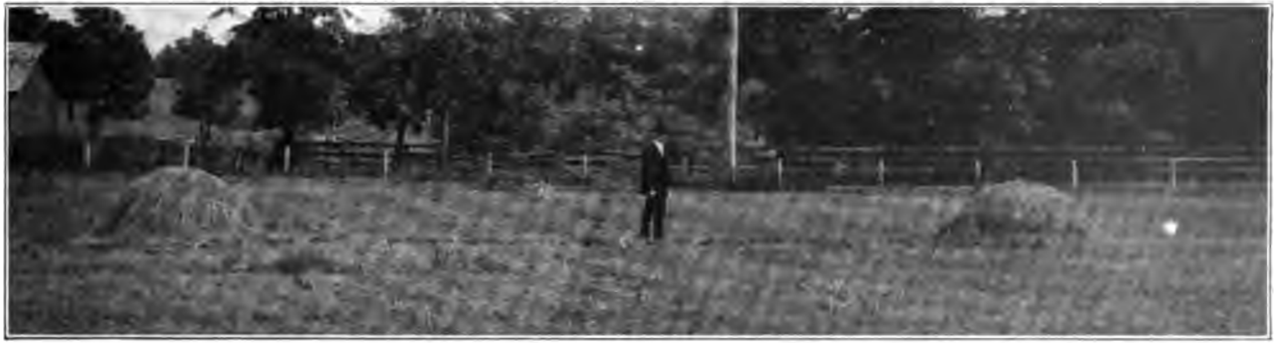


Plat 29.
Nitrogen and Potash.

Plat 28.
Phosphoric Acid and Potash.

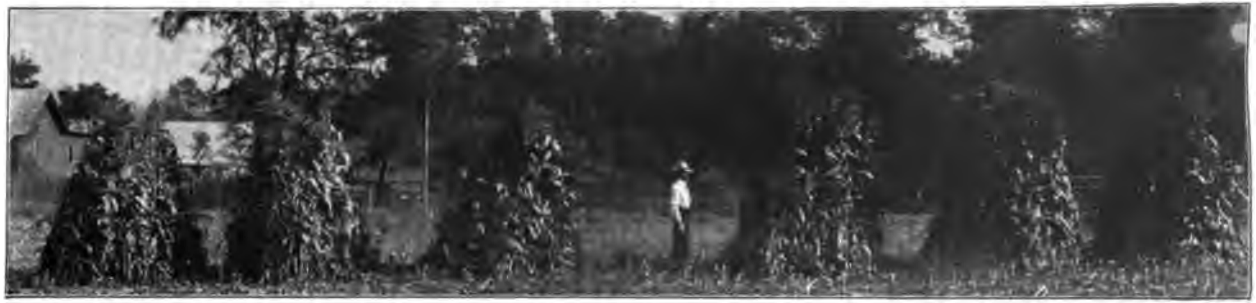
HAY IN 1909.



Plat 29.
Nitrogen and Potash.

Phosphoric Acid and Potash.
Plat 28.

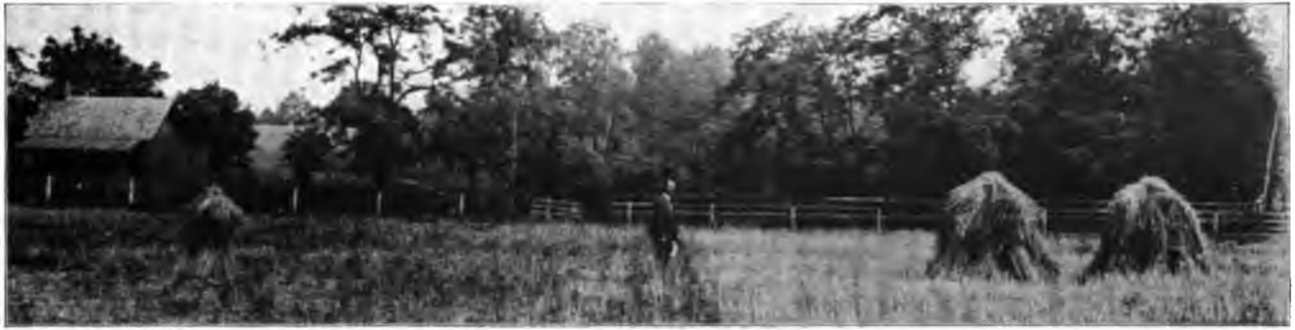
HAY IN 1910.



Plat 29.
Nitrogen and Potash.

Plat 28.
Phosphoric Acid and Potash.

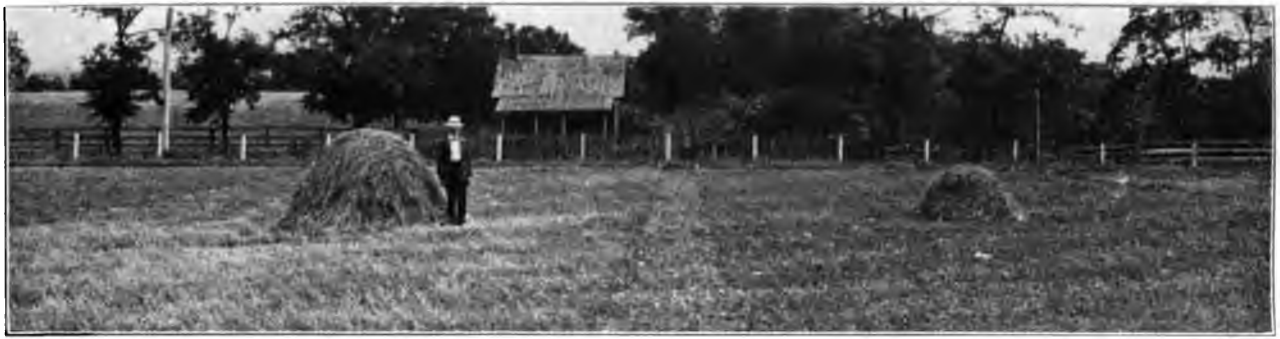
CORN IN 1905.



Plat 29.
Nitrogen and Potash.

Plat 28.
Phosphoric Acid and Potash.

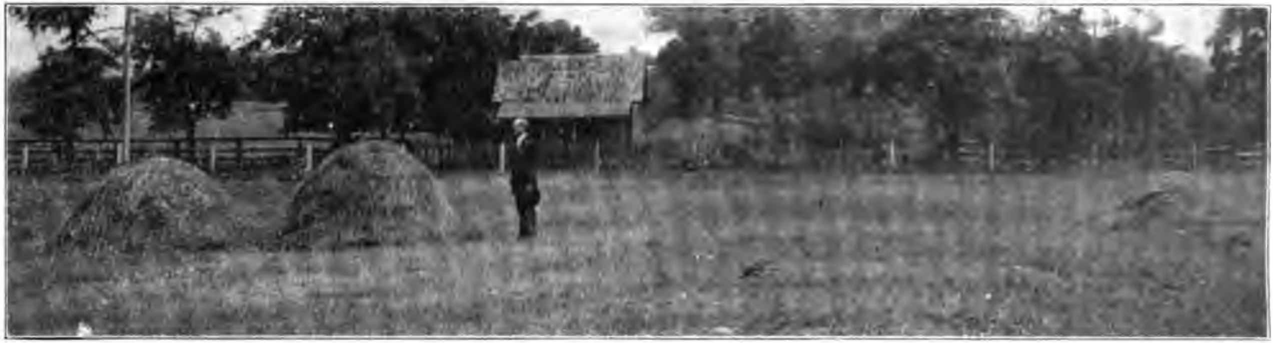
RYE IN 1907.



Plat 31.
Nitrogen and Phosphoric Acid.

Plat 30.
No Fertilizer.

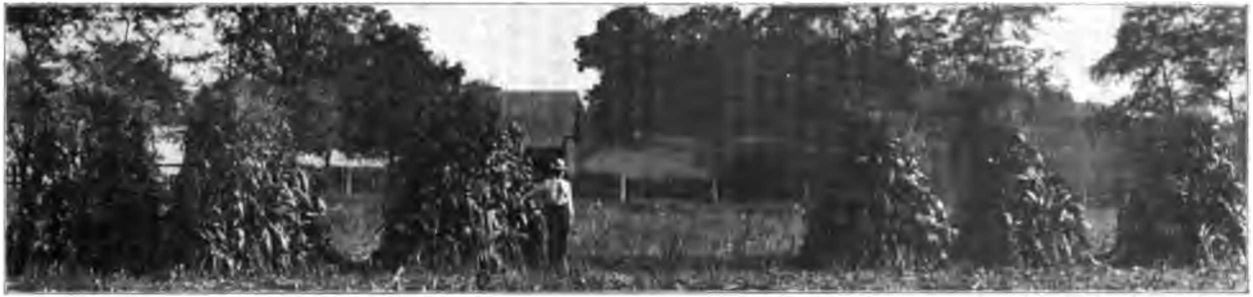
HAY IN 1909.



Plat 31.
Nitrogen and Phosphoric Acid.

Plat 30.
No Fertilizer.

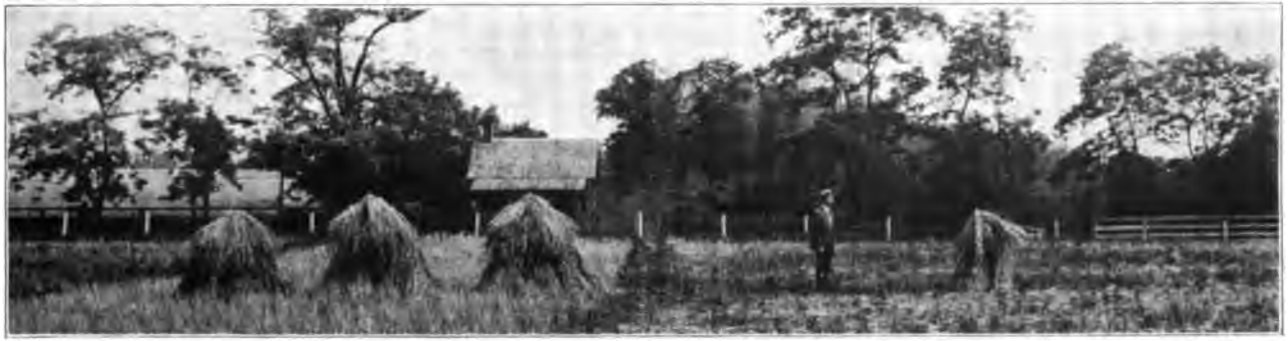
HAY IN 1910.



PLAT 31.
NITROGEN AND PHOSPHORIC ACID.

PLAT 30.
NO FERTILIZER.

CORN IN 1905.



PLAT 31.
NITROGEN AND PHOSPHORIC ACID.

PLAT 30.
NO FERTILIZER.

RYE IN 1907.

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yields, however, both with corn and clover, has been in favor of the double salt.

The following table shows the excess or decrease in the yield of the remaining fertilized plats as compared with the average yield of the two nearest unfertilized ones:

Plat		Corn.	Stalks.
19	Excess over plat 21...........................	420	300
20	“ “ 21...........................	570	560
22	Decrease from the average of plats 21 and 24...	26	52
23	Excess over “ “ 21 and 24...	253	208
25	“ “ “ “ 24 and 27...	336	295
26	“ “ “ “ 24 and 27...	375	345
28	“ “ “ “ 27 and 30...	326	268
29	Decrease from “ “ 27 and 30...	40	22
31	Excess over “ “ 30 and 33...	353	340
32	“ “ “ “ 30 and 33...	13	15
34	“ “ “ “ 33 and 36...	286	240
35	Decrease from “ “ 33 and 36...	38	5

Observations Concerning the Results Shown in the Preceding Table.

1. The plat to which only sodium nitrate was applied did not yield as well as the average of the two nearest unfertilized plats.

2. The application of acid phosphate materially increased the yield of both corn and stover.

3. Potassium sulphate when applied alone increased the yield but slightly when compared with the average of the two nearest unfertilized plats.

4. Plats 28 and 31, to the former of which potash and phosphoric acid have been applied, and to the latter nitrogen and phosphoric acid, yielded considerably more than the plat which has received only phosphoric acid.

5. Plat 29, fertilized with sodium nitrate and potassium sulphate, did not yield as well as the average of the two nearest unfertilized plats.

6. The plats which received all three constituents gave a

larger increase than where sodium nitrate or potassium sulphate have been individually applied with acid phosphate.

7. Comparing the yields of plats 23 and 25, it is seen that the plat which has received two applications of stable manure gave a larger increase than the plat which has received the ash of stable manure and sodium nitrate.

8. Plat 22, which has received two small applications of lime, did not yield as well as the average of the two nearest unfertilized plats.

9. Comparing the excess yields of plats 19 and 26, which have been uniformly fertilized with nitrogen, potash and phosphoric acid, with the addition of lime to plat 19, in 1900, it is seen that the limed plat gave a larger yield of corn with a smaller growth of stalks than the other plat.

10. The largest excess yield was obtained from plat 20, which in addition to three applications of stable manure was limed in 1900.

FIFTH YEAR OF THE TEST.

After the corn was removed in the autumn of 1903, rye was drilled upon all of the plats as a cover crop, no fertilizer being used. The small amount of growth which resulted was plowed under in the spring of 1904, and the land prepared for cowpeas, which were sown June 9th, the black variety being employed.

The fertilizers were applied shortly before the seed was sown and thoroughly harrowed into the soil. The same kind and amount of fertilizer was applied as was the case the first year of the test, with the exception that no more lime was applied to plats 19, 20 and 22; no further application was made to plat 23: and acid phosphate was substituted in all cases for Thomas slag.

The plats were cut for hay October 6th. The vines were allowed to cure for about one week and were then weighed. The following table shows the weight of the hay obtained from the different plats:

	Pounds Hay.		Pounds Hay
Plats 13 to 18 inclusive....	800	Plat 27	220
Plat 19	695	Plat 28	440
Plat 20	675	Plat 29	230
Plat 21	125	Plat 30	210
Plat 22	120	Plat 31	515
Plat 23	275	Plat 32	195
Plat 24	135	Plat 33	245
Plat 25	610	Plat 34	365
Plat 26	630	Plat 35	250

The following table shows the increase or the decrease in the yields of the fertilized plats when compared with the average of the two nearest plats which have remained unfertilized:

Plat 19	Excess over 21..................................	570 lbs.
Plat 20	“ “ 21..................................	550 lbs.
Plat 22	Decrease from the average yield of 21 and 24....	10 lbs.
Plat 23	Excess over “ “ 21 and 24....	145 lbs.
Plat 25	“ “ “ “ 24 and 27....	433 lbs.
Plat 26	“ “ “ “ 24 and 27....	453 lbs.
Plat 28	“ “ “ “ 27 and 30....	225 lbs.
Plat 29	“ “ “ “ 27 and 30....	5 lbs.
Plat 31	“ “ “ “ 30 and 33....	288 lbs.
Plat 32	Decrease from “ “ 30 and 33....	32 lbs.
Plat 34	Excess over 33..................................	120 lbs.
Plat 35	“ “ 33..................................	5 lbs.

OBSERVATIONS CONCERNING THESE RESULTS.

1. Plat 35, to which sodium nitrate was applied, yielded practically the same as plat 33, to which no fertilizer has been applied since the beginning of the test.

2. The application of acid phosphate to plat 34 materially increased the yield.

3. Plat 32, to which potassium sulphate was applied, gave a smaller yield than the average of the two nearest unfertilized plats.

4. In the case of plats 28 and 31, to the former of which potassium sulphate, and to the latter sodium nitrate was used in

connection with acid phosphate, the application of these salts in connection with acid phosphate practically doubled the excess yields as compared with the plat to which acid phosphate was applied alone.

5. Plat 29 fertilized with potassium sulphate and sodium nitrate, yielded practically the same as the average of the two unfertilized plats.

6. Plat 26, to which sodium nitrate, potassium sulphate and acid phosphate were applied, gave a slightly larger excess than the plat to which stable manure was applied. This plat also gave a much larger excess than plats 28 and 31, to which sodium nitrate and potassium sulphate were individually applied with acid phosphate.

7. Plat 23, to which the ash of stable manure and nitrogen were applied during the first two years of the test still shows the influence of this fertilization.

8. Former applications of lime to plat 22 seem to have exerted a deleterious influence.

9. Comparing the excess yields of plats 19 and 26, it is seen that the plat which has received one application of lime in addition to other fertilizers gave a larger excess yield than the plat to which no lime has been applied. This plat also gave the largest actual, as well as the largest excess yield, of any of the plats, closely followed by plat 20, which has been continuously fertilized with stable manure, except when the land was in clover, and has received in addition one application of lime.

SIXTH YEAR OF THE TEST.

The plats were plowed in the spring and prepared for corn, which was planted May 23rd, the Ensilage Red Cob variety being used. The rows were three and one-half feet apart, and the hills two feet apart in the row, and the corn planter was adjusted so as to plant two kernels in a hill.

The fertilizers were applied broadcast a few days before the corn was planted and harrowed into the soil. No lime was applied to plats 19, 20 and 22; no more fertilizer was applied to plat 23; and acid phosphate was used instead of Thomas slag. Except as noted the same kind and amount of fertilizer was applied to the different plats as in the first year of the test.

The corn on these plats was used for ensilage. It was cut and shocked on the 23rd and 25th of September, and photographed and weighed on the 26th. When cut the kernels on the plats which have been fertilized were mostly glazed, while the grain on the unfertilized plats was mostly in the milk.

The following table gives the weight of the crops from the different plats.

	Pounds.		Pounds.
Plat 18	930	Plat 27	1250
Plat 19	2770	Plat 28	1610
Plat 20	3470	Plat 29	1500
Plat 21	1120	Plat 30	1090
Plat 22	980	Plat 31	1890
Plat 23	1530	Plat 32	1180
Plat 24	1210	Plat 33	870
Plat 25	3480	Plat 34	1410
Plat 26	2900	Plat 35	1020

The following table shows the increase or the decrease in the yields of the fertilized plats when compared with the average of the two nearest plats which have been unfertilized:

Plat 19	Excess over the average of plats	18 and 21....	1745 lbs.
Plat 20	“ “ “ “	18 and 21....	2445 lbs.
Plat 22	Decrease from “ “	21 and 24....	185 lbs.
Plat 23	Excess over “ “	21 and 24....	365 lbs.
Plat 25	“ “ “ “	24 and 27....	2250 lbs.
Plat 26	“ “ “ “	24 and 27....	1670 lbs.
Plat 28	“ “ “ “	27 and 30....	440 lbs.
Plat 29	“ “ “ “	27 and 30....	330 lbs.
Plat 31	“ “ “ “	30 and 33....	910 lbs.
Plat 32	“ “ “ “	30 and 33....	200 lbs.
Plat 35	Excess over plat 33	....	540 lbs.
Plat 35	“ “ 33	....	150 lbs.

OBSERVATIONS CONCERNING THESE RESULTS.

1. Somewhat in contrast with the results obtained in former years, sodium nitrate and potassium sulphate when applied alone were of some benefit. The acid phosphate, however, gave an increase more than three times as large as that derived from the use of sodium nitrate and more than two and one-half times as large as the increase from the use of potassium sulphate.

2. Plat 31, which received a mixture of sodium nitrate and acid phosphate, gave a larger increase in the yield than the total increase on the three plats, 32, 34 and 35, which were fertilized with potassium sulphate, acid phosphate and sodium nitrate. This agrees fully with the results obtained with corn during the fourth year of the test.

3. The application of the mixture of sodium nitrate and potassium sulphate to plat 29 produced about the same increase as the total increase on the two plats to which they were applied alone.

4. Plat 28, which received a mixture of potassium sulphate and acid phosphate, did not yield as large an increase as plat 34, to which only acid phosphate was applied.

5. Plat 26, which received the three constituents, nitrogen, potash and phosphoric acid, gave a much larger excess than was produced by a mixture of any two constituents.

6. The largest yield and the largest excess yields were produced by plats 20 and 24, which have been fertilized with stable manure. The actual yield of the two plats are practically identical, but plat 20, which has been limed, gave a slightly larger excess.

7. Plat 23, which received the ash of stable manure, still shows the beneficial effect of the ash constituents.

8. As in former years, the yield of the limed plat has failed to come up to the average of the unfertilized plats.

SEVENTH YEAR OF THE TEST.

In the autumn of 1905 the plats were seeded to rye as a cover crop. This was plowed under in the spring of 1906, and the land prepared for potatoes. The various fertilizers were applied April, 28th, and the potatoes were planted May 4th. The variety employed was Early Ohio, and 15 bushels of seed were used per acre. The rows were furrowed out by a one-horse plow, 3 feet 3 inches apart, and the seed potatoes dropped about 8 inches apart in the rows.

Owing to the wet spring which delayed the planting of the potatoes, and to early blight which began to kill the foliage in July, the yield of potatoes was small. The following table shows the total pounds of potatoes harvested per acre. Digging was begun August 11th and completed a day or two afterwards.

Yield of Potatoes in Pounds Per Acre.

Plat 19	6120	Plat 28	6360
Plat 20	13060	Plat 29	3520
Plat 21	2600	Plat 30	2140
Plat 22	1520	Plat 31	3830
Plat 23	2500	Plat 32	2630
Plat 24	2610	Plat 33	2400
Plat 25	11300	Plat 34	3800
Plat 26	7030	Plat 35	2250
Plat 27	2850	Plat 36	2180

The following table shows the increase or the decrease in the yields of the fertilied plats when compared with the average of the two nearest plats that have remained unfertilied.

Plat 19	Excess over the yield of	21	3520 lbs.
Plat 20	" " "	21	10460 lbs.
Plat 22	Decrease from the average yield of	21 and 24	1085 lbs.
Plat 23	" " " "	21 and 24	105 lbs.
Plat 25	Excess over " "	24 and 27	8570 lbs.
Plat 26	" " " "	24 and 27	4300 lbs.
Plat 28	" " " "	27 and 30	3865 lbs.
Plat 29	" " " "	27 and 30	1025 lbs.
Plat 31	" " " "	30 and 33	1560 lbs.
Plat 32	" " " "	30 and 33	360 lbs.
Plat 34	" " " "	33 and 36	1510 lbs.
Plat 35	Decrease from " "	33 and 36	40 lbs.

Observation Concerning the Results Shown in the Preceding Tables.

1. Sodium nitrate when used alone as on plat 35, or when used with acid phosphate as on plat 30, was apparently of little or no value. When used with potassium sulphate, however, there was a slightly increased yield as compared with the plat to which potassium sulphate was applied alone.

2. Acid phosphate when used alone increased the yield about 25 bushels per acre, as compared with the no-fertilizer plats, and when used in connection with potassium sulphate the yield was increased about 64 bushels per acre.

3. Potassium sulphate when used alone or in connection with acid phosphate or sodium nitrate increased the yields, the largest increase taking place when used in connection with acid phosphate.

4. When a mixture of all three of the fertilizing materials was used the total and also the excess yield was greater than when any two of the materials were used together.

5. The two plats, 20 and 25, which received stable manure produced by far the largest and most satisfactory yields. The vines on these two plats grew more luxuriantly than upon any of the others, and much of the foliage remained green and thrifty after the vines on adjoining plats were dead and withered.

6. Lime when used alone or in connection with commercial fertilizer decreased the yield. When used in connection with stable manure the yield of potatoes was the heaviest of any in the test, being slightly more than 200 bushels per acre.

EIGHTH YEAR OF THE TEST.

The plats from which potatoes had been harvested were plowed in the early part of September, harrowed and drilled to rye September 28th, five pecks of seed being used per acre. As it was desirable to study the residual effect of the previous manurings no fertilizer was applied to any of the plats.

The rye was cradled July 10th-15th, bound by hand, and set up in shocks. These were photographed July 19th. and the cuts show the appearance of the plats at that time.

Owing to difficulty in procuring a threshing machine the shocks remained in the field until September 24th, and it is probable there was more or less loss of grain on account of birds and mice. The rye was then weighed and threshed. The shock of rye on plat 22 was struck by lightning and burned while standing in the field, and consequently was not weighed.

The following table shows the yield of grain and straw from the various plats stated in pounds per acre:

YIELD OF RYE IN 1907.

	Straw.	Grain.		Straw.	Grain.
Plat 19	3030	1170	Plat 28	1850	850
Plat 20	4860	2140	Plat 29	260	140
Plat 21	360	140	Plat 30	250	160
Plat 22 Struck by lightening and not weighed.			Plat 31	2270	1030
			Plat 32	360	140
Plat 23	280	170	Plat 33	280	120
Plat 24	380	140	Plat 34	1930	770
Plat 25	4420	1880	Plat 35	290	210
Plat 26	2530	1170	Plat 36	270	130
Plat 27	290	160			

The table shows that the crop on all but five or six of the plats was very small.

In the following table the yield of grain from each plat that has been fertilized is compared with the average yield of the two nearest plats that have been continuously unfertilized:

Plat 19	Excess over yield of plat 21.....................	1030 lbs.
Plat 20	" " " 21.....................	2000 lbs.
Plat 23	Excess over average yield of plats 21 and 24....	30 lbs.
Plat 25	" " " " 24 and 27....	1730 lbs.
Plat 26	" " " " 24 and 27....	1020 lbs.
Plat 28	" " " " 27 and 30....	690 lbs.
Plat 29	Decrease from " " 27 and 30....	20 lbs.

Plat 31	Excess over	"	"	30 and 33....	890 lbs.
Plat 32	" "	"	"	30 and 33....	0 lbs.
Plat 34	" "	"	"	33 and 36....	645 lbs.
Plat 35	" "	"	"	33 and 36....	85 lbs.

Remembering that no fertilizer was applied to any of the plats for this crop of rye, the following observations may be made:

1. The plat to which acid phosphate has been applied alone produced a much better crop than the plats to which either sodium nitrate or potassium sulphate have been applied alone, and about 11 bushels per acre more than the no-fertilizer plats.

2. Former applications of a mixture of sodium nitrate and potassium sulphate seem to have a depressing effect upon the yield of rye, while former applications of a mixture of sodium nitrate and acid phosphate, or of potassium sulphate and acid phosphate increased the yields, the former mixture acting somewhat more beneficially than the latter.

3. Former applications of a mixture of all three fertilizing constituents acted somewhat more beneficially than a mixture of any two of them.

4. The stable manure plats, 20 and 25, gave the largest total and also the largest excess yields. Plat 20, which in addition to stable manure had received lime, yielded at the rate of slightly more than 38 bushels of rye per acre, while the no-fertilizer plats averaged slightly less than 3 bushels of rye per acre.

5. The plat which had received lime only was not weighed as already noted, but the cut of this plat shows that the yield was no greater than that on the adjoining no-fertilizer plats. Comparing the excess yields of plats 19 and 26, it is seen that the use of lime on plat 19 was without effect upon the yield of grain, although the growth of straw seems to have been favored by the presence of the lime. Plat 20, which has received stable manure and lime, gave a larger yield of both grain and straw than plat 25, which has received stable manure only. Plat 20, however, has received, since the beginning of the test, two tons of stable manure more than has been applied to plat 25, which possibly might account for some of this difference.

NINTH YEAR OF THE TEST.

After the rye was harvested in the fall of 1907 the plats were plowed and seeded to timothy, no fertilizer being applied to any of the plats. Clover seed was sown in the spring . The stand of grass being very poor on account of an unfavorable season the little growth which resulted was not harvested and weighed, but it was cut and allowed to remain on the plats.

TENTH YEAR OF THE TEST.

In the spring of 1909 the plats were harrowed with a smoothing harrow and a mixture of timothy and clover seed was sown at the rate of twenty pounds per acre. The stable manure was spread on plats 20 and 25 in March, and the remainder of the fertilizers was applied by means of a grain drill May 17th. No lime was used.

The grass was cut July 13th, and the shocks of hay were photographed and weighed on the 19th.

The following table gives the yield of hay in pounds per acre.

	Pounds hay per acre
Plat 18	610
Plat 19	5600
Plat 20	6800
Plat 21	755
Plat 22	535
Plat 23	490
Plat 24	535
Plat 25	7800
Plat 26	4700
Plat 27	505
Plat 28	1640
Plat 29	2125
Plat 30	705
Plat 31	4500
Plat 32	430
Plat 33	305
Plat 34	845
Plat 35	720

The following table shows the excess yields of the fertilized plats as compared with the no-fertilizer plats adjoining.

Plat 19	Excess over the average of 18 and 21	4917
Plat 20	“ “ “ “ “ 18 and 21	6117
Plat 22	Decrease from the average of 21 and 24	21
Plat 23	“ “ “ “ “ 21 and 24	66
Plat 25	Excess over the average of 24 and 27	7280
Plat 26	“ “ “ “ “ 24 and 27	4180
Plat 28	“ “ “ “ “ 27 and 30	1035
Plat 29	“ “ “ “ “ 27 and 30	1520
Plat 31	“ “ “ “ “ 30 and 33	3995
Plat 32	Decrease from the average of 30 and 33	75
Plat 34	Excess over Plat 33	540
Plat 35	“ “ “ “	415

Observations concerning these results.

1. Sodium nitrate when used alone was only of slight benefit in increasing the growth of grass.

2. When used alone acid phosphate produces only a slight increase in the crop.

3. The plat to which potassium sulphate was applied did not yield quite so well as the average of the two nearest unfertilized plats.

4. The mixture of sodium nitrate and acid phosphate increased the yield of hay nearly two tons per acre.

5. The mixture of sodium nitrate and potassium sulphate increased the yield of hay slightly more than 1500 pounds per acre and was considerably less effective than the mixture of nitrate and phosphate.

6. The mixture of potash and phosphoric acid produced an increase in the yield of about 1000 pounds of hay per acre, and was considerably less efficient than either the mixture of nitrogen and phosphoric acid, or the mixture of nitrogen and potash.

7. Plat 26 to which all three constituents were applied gave a larger excess yield than any of the plats on which any two constituents were used.

8. The greatest excess yield was produced by the plat to

which stable manure was applied, followed by the stable manure and lime plat, while somewhat in the rear stands the plat to which all three constituents have been applied together with lime.

9. As in former years plat 22 on which lime has been used alone gave a slightly decreased yield.

ELEVENTH YEAR OF THE TEST.

The plats were allowed to remain in grass, and the same kind and amount of fertilizer as was used the first year of the test was applied as a top dressing April 9, 1910. The stable manure was spread on plats 20 and 25 in March. No lime was used.

The grass was cut July 5th, photographed on the 7th, and weighed on the 11th. The following table gives the weight of the hay from the various plats in pounds per acre.

	Pounds hay per acre
Plat 18	1130
Plat 19	9000
Plat 20	10400
Plat 21	1305
Plat 22	1240
Plat 23	1120
Plat 24	1180
Plat 25	9000
Plat 26	8700
Plat 27	1275
Plat 28	3475
Plat 29	3880
Plat 30	1375
Plat 31	7300
Plat 32	1285
Plat 33	1260
Plat 34	3410
Plat 35	2885

The excess yields of the fertilized plats is shown in the following table.

Plat 19	Excess over the average of 18 and 21	7782
Plat 20	" " " " " 18 and 21	9182
Plat 22	Decrease from the average of 21 and 24	3
Plat 23	" " " " " 21 and 24	123
Plat 25	Excess over the average of 24 and 27	8772
Plat 26	" " " " " 24 and 27	7472
Plat 28	" " " " " 27 and 30	2150
Plat 29	" " " " " 27 and 30	2555
Plat 31	" " " " " 30 and 33	5982
Plat 32	Decrease from the average of 30 and 33	33
Plat 34	Excess over plat 33	2150
Plat 35	" " " "	1625

Observations concerning these results.

The table shows that the largest excess yield was produced by the plat which has had applications of stable manure together with lime. Next in order stands the stable manure plat, followed by plat 19 which has received applications of all three constituents and lime. This in turn is followed by plat 26 which has received the same fertilizers as plat 19 without the lime. In this case, then, former applications of lime to plats 19 and 20 have apparently increased the yield of hay about 400 pounds per acre, but where used alone on plat 22 it still shows a detrimental effect.

Where two constituents were applied the best yield was obtained from the mixture of sodium nitrate and acid phosphate. The addition of potassium sulphate to the acid phosphate did not increase the yield, although when the potassium sulphate was used with sodium nitrate there was considerable increase as compared with the yield of the plat to which sodium nitrate was applied alone.

For the purpose of comparing the results obtained during the different years the following table has been prepared, showing the excess yields for the ten years under consideration:

SUMMARY OF "EXCESS YIELDS" STATED IN POUNDS PER ACRE.

Plat	RYE 1900		WHEAT 1901		CLOVER 1902	CORN 1903		COWPEAS 1904	CORN 1905	POTATOES 1906	RYE 1907	HAY 1909	HAY 1910
	Straw	Grain	Straw	Grain	Hay	Corn	Stover	Hay	Entire Crop	Potatoes	Grain		
19	1300	876	....	...	4650	4200	3000	5700	17,450	3520	1030	4917	7782
20	538	378	3400	700	6800	5700	5600	5500	24,450	10,460	2000	6117	9182
22	—254	—66	—5	—95	—575	—260	—520	—100	—1850	1085	....	—21	—3
23	1778	952	1825	775	5825	2530	2080	1450	3650	105	30	—66	—123
25	1261	715	2775	825	7075	3360	2950	4330	22,500	8570	1730	7280	8772
26	1991	1265	2145	665	4775	3750	3450	4530	16.700	4300	1020	4180	7472
28	178	93	1635	465	2750	3260	2680	2250	4400	3865	690	1035	2150
29	999	662	105	—5	—750	—400	—220	50	3300	1025	—20	1520	2555
31	1583	932	1730	470	5475	3530	3400	2880	9100	1560	890	3995	5982
32	108	67	—150	—50	75	130	150	—320	2000	360	0	—75	—33
34	320	85	990	460	3200	2860	2400	1200	5400	1510	645	540	2150
35	1226	639	150	0	400	—380	—50	50	1500	—40	85	415	1625

SUMMARY AND CONCLUSIONS FOR THE ENTIRE PERIOD.

1. **Nitrogen.** Sodium nitrate has been of benefit, when applied alone, only when it was used as a top-dressing in the spring on rye, and grass. When used in connection with phosphoric acid it has uniformly increased the yields when compared with the plat to which phosphoric acid has been applied alone. When used in connection with potassium sulphate the yields have been generally unsatisfactory, except when the mixture was applied to rye and grass as a top-dressing in the spring.

2. **Potash.** When potassium sulphate has been used alone the yields have been either only slightly larger or actually smaller than the average of the two nearest unfertilized plats. When used with phosphoric acid the excess yields have been, in general, only slightly larger than when phosphoric acid has been used alone.

3. **Phosphoric Acid.** When applied alone Thomas slag and acid phosphate have uniformly increased the yields. When a mixture containing the three constituents, nitrogen, potash and phosphoric acid, has been applied the excess yields have been larger, with a single exception, than when any one or any two constituents have been employed.

4. **Potash and Nitrogen.** The mixture containing potash and nitrogen has given poorer results than the mixture containing either potash and phosphoric acid, or nitrogen and phosphoric acid except in one or two instances when the fertilizer was applied in the spring as a top-dressing. This indicates *that in this soil the stock of available phosphoric acid is so low that the deficiency of this constituent must be supplied before either nitrogen or potash can be of any particular value.*

5. **Nitrogen and Phosphoric Acid.** With rye, wheat, clover, corn, cowpeas and timothy the mixture containing nitrogen and phosphoric acid gave larger excess yields than did a mixture containing potash and phosphoric acid, or, in other words, *after the deficiency of phosphoric acid is supplied the crops mentioned feel the lack of nitrogen in this soil more acutely than they do*

of potash. In the case of potatoes, however, the opposite seems to be true, as the plat fertilized with a mixture of phosphoric acid and potash gave a considerably larger excess yield than the plat to which phosphoric acid and nitrogen were applied.

6. STABLE MANURE. Stable manure has increased the yields materially and uniformly. Plat 25, which received two applications of stable manure during the first and second years of the test, yielded almost as much corn in 1903 as plat 26, which had received up to that time three applications of complete fertilizer. During the first year when it was applied as a top-dressing the excess yield was somewhat smaller than that obtained from the complete fertilizer plat. During the second year the excess yield was larger, and during the third year when no fertilizer was applied to any of the plats, the yield of clover hay was almost double that obtained from the plats to which the complete fertilizer had been applied. During the last few years the excess yields have been larger than the excess yields of plat 26, which has received a mixture containing nitrogen, potash and phosphoric acid.

7. LIME. The two applications of lime applied to plat 22 have reduced the yields as compared with the average of the two nearest unfertilized plats. Comparing the excess yields of plats 19 and 26, it is seen that the lime applied to plat 19 during the first year of the test seems to have reduced the yield during the first three years and to have acted somewhat favorably during the remainder of the time, except in 1906 when potatoes were grown. During the first three years of the test plats 20 and 25 received the same amount of stable manure. The lime applied to plat 20 seems to have favored the growth of the crop during the second year, as the wheat grew so luxuriantly that it lodged badly. In 1902 the excess yield of clover hay was slightly lower than in the case of plat 25, and the yields during succeeding years are not strictly comparable, as plat 20 received a dressing of stable manure in 1903, which was not given plat 25. So in general we may say that with lime the results on this soil have not been fully satisfactory, although during the last few years of the test it seems to have been of some benefit.

8. Humus. During the first two years of the test plat 25 received two applications of stable manure and plat 23 two applications of the ash of stable manure and an equivalent amount of nitrogen in the form of sodium nitrate. Neither of these two plats received any further application of fertilizer for the next two years. We may compare, therefore, their yields for the first four years of the test.

Except during the first year of the test, the plat which has received stable manure has produced a larger excess yield than the plat receiving the ash of stable manure and nitrogen. Whether this favorable effect of the stable manure has been due to the gradual liberation of plant food during the growing season; to the greater amount of moisture which the soil is capable of holding and supplying to the crop or to other factors, is a matter which has not been answered definitely. It is entirely probable that several factors may have aided in producing the larger yields of the stable manure plat.

9. The Fertilizer Requirements of Different Crops. From the results obtained in this test it may be stated that, within the limits of the crops grown, a fertilizer which gives good results with one crop will give good results with another crop grown upon the same or similar soil. For example, the application of a fertilizer containing phosphoric acid gave good results with rye, wheat, clover, cowpeas, and corn. Similarly, stable manure gave good results in all cases. The table shows, however, that there are some minor exceptions to this general rule. For if the yield of cowpeas and corn are compared during the last two years of the test, it is seen that the cowpeas which received a mixture of sodium nitrate, acid phosphate, and potassium sulphate (plats 19 and 26), gave a larger excess yield than when supplied with stable manure (plats 20 and 25), while in the case of corn in 1905 the exact opposite is true. Also in 1903 the corn on plat 20, fertilized with stable manure gave a larger excess than on plat 19, dressed with commercial fertilizer, and the same probably would have been true in the case of plats 25 and 26 had not the stable manure plat been injured and the yield reduced by a very heavy thunder shower which caused a stream

of water to cut a channel diagonally across this plat. From this evidence we may conclude *that corn responds more favorably to a dressing of stable manure than it does to an application of commercial fertilizer, while with cowpeas the exact opposite is true.* This conclusion, also, is in entire agreement with common farm practice in which stable manure is generally used for corn, and commercial fertilizer for cowpeas. It may be observed here that although the roots of these cowpeas were well supplied with nodules yet the plats receiving all three fertilizing constituents (plats 19 and 26) gave larger excesses than when any one or any two constituents were supplied. Also that a mixture of sodium nitrate and acid phosphate gave slightly better results than a mixture of potassium sulphate and acid phosphate, although cowpeas are supposed to be able to obtain their supplies of nitrogen from the free nitrogen of the air when provided with root tubercles. Also that potatoes seemed to respond better to applications of potash salts than any of the other crops.

PRACTICAL SUGGESTIONS.

This experiment shows that this soil is very deficient in available phosphoric acid, and that as soon as this deficiency is supplied then there is a lack of nitrogen and to a less extent of potash also.

When commercial fertilizers are relied upon entirely to maintain a high degree of crop production a fertilizer containing all three constituents, nitrogen, potash, and phosphoric acid will give better results than a fertilizer containing only one or two of these constituents. Aside from the fact that a fertilizer should be especially rich in phosphoric acid these experiments do not indicate the exact proportion in which nitrogen, potash and phosphoric acid should enter into a fertilizer for best results. This will be made the subject of further study.

If leguminous crops are raised and either plowed under or fed on the farm and the resulting manure carefully saved and applied to the soil it is very probable that in practice it will be necessary to purchase only phosphoric acid in order to increase the productiveness of soils of this type and to maintain them in a condition of high fertility.

Stable manure has demonstrated again its great value as a restorer of fertility to a poor worn out soil. More manure should be produced on West Virginia farms, it should be protected from leaching and heating more carefully, and should be applied to the soil more systematically and more intelligently than is the case at the present time.

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 132. December, 1910.

IVERSITY

COMMERCIAL FERTILIZERS

A COMPLETE REPORT FOR 1910

BY

B. H. HITE AND F. B. KUNST

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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COMMERCIAL FERTILIZERS.

Complete Report for 1910. Bulletin 132.

With few exceptions, manufacturers of commercial fertilizers doing business in this state, are making every reasonable endeavor to provide the quantity of every constituent guaranteed. Fertilizer laws everywhere require such a guarantee, and manufacturers have learend to cut remarkably close to the minimum figure without much danger of falling below it.

West Virginia is one of the very few states that requires a guarantee, not only as to the quantity but also as to the quality of every constituent mentioned as contributing to the value of a fertilizer. The quality of the materials used may be a matter of as great or even greater concern than the quantity. A difference of a few tenths of a per cent of nitrogen is an almost negligible matter compared with the difference between nitrate of soda and garbage tankage.

More or less reluctance in stating the materials used is to be expected, especially at the hands of those who are determined to use as much low grade material as possible, and purchasers of the various brands of fertilizers hereinafter mentioned should note carefully any failure to provide materials of the quality guaranteed. Such failures are never of the order just mentioned. No one has guaranteed nitrate of soda or dried blood and used garbage or muck tankage. When low grade materials are used they are almost always mentioned, the failures referred to being largely a matter of using the low grade materials in larger proportions than guaranteed; or some low grade material guaranteed is replaced in part or entirely by some yet lower grade material. A good rule is to watch the tags and if a low grade material is mentioned, to have nothing to do with the fertilizer. The sort of low grade materials or the proportion in which they are used should be a matter of very little concern, so long as it is known that any sort of low grade material is used in any proportion. This and all other information necessary in selecting fertilizers is plainly printed on the tags attached to every sack.

The fertilizer law of this state is doing everything that a good law can do and a great deal more than fertilizer laws as a rule make any attempt to do.

RESULTS OF INSPECTION OF COMMERCIAL FERTILIZERS FOR 1910.

The American Agricultural Chemical Company, New York.

5457. A Ground Bone. Johnson Implement Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, total 25%; nitrogen 1.23; Phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 27.51; nitrogen 1.36; availability of nitrogen 85.

6458. A. A. C. Co.'s. Special Potash Mixture. Johnson Implement Co., Parkersburg, W. Va. Guarantee: Phosphoric Acid, soluble 4; reverted 1; insoluble 1.50; total 6.50; available 5; nitrogen 0.82; potash 10; phosphoric acid from 1-5 to 2-5 animal bone 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 from kainit 1-3 to 2-3 from muriate. Found: Phosphoric acid, soluble 4.07; reverted 1.20; insoluble 0.88; total 6.15; available 5.27; nitrogen 0.91; potash 10.21; availability of nitrogen 81; chlorine 0.5.

6466. A. A. C. Co.'s Fine Ground Bone. O. R. Carmen, Agent, Wellsburg, W. Va. Guarantee: Phosphoric acid, total 22.88; nitrogen 2.47; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 26.98; nitrogen 2.83; availability of nitrogen 90.

6519. Pure Ground Bone. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee, Phosphoric acid, total, 20.59; nitrogen 3.29; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 21.23; nitrogen 3.50; availability of nitrogen 70.

6559. Bone Meal. W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, total 13.73; nitrogen 1.65; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 15.65; nitrogen 1.77; availability of nitrogen 91.

5616. Dissolved Animal Bone. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 2; insoluble 2; total 14; available 12; nitrogen 2.06; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, soluble, 8.02; reverted 3.27; insoluble 1.80; total 13.09; available 11.29; nitrogen 1.96; availability of nitrogen 85. Remark: Phosphoric acid, low.

6480. Regular Corn Fertilizer. A. S. Ford, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; potash 3; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit; 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 3.80; reverted 3.36; insoluble 0.63; total 7.79; available 7.16; potash 3.03; chlorine 6.1; Remarks: Chlorine excessive.

6505. A. A. C. Co's. Fish Guano. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.82; potash 2; phosphoric acid 1-5 to 2-5 fish, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 3-5 to 4-5 fish; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: phosphoric acid, soluble 5.13; reverted 3.26; insoluble 0.74; total 9.13; available 8.39; nitrogen 0.92; potash 2.15; availability of nitrogen 72; chlorine 3.7. Remarks: Availability of nitrogen too low for material guaranteed. Chlorine excessive.

6554. Corn, Oats and Buckwheat Fertilizer. W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, soluble 4.00; reverted 2.00; insoluble 1; total 7; available 6; potash 3: phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit; 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 2.73; reverted 3.64; insoluble 0.75; total 7.12; available 6.37; potash 3.53; chlorine 5.8. Remark: Chlorine excessive.

6555. A. A. C. Co's. Wheat, Corn & Grass Mixture, W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen 0.41; potash 2; phasphoric acid 1-5 to 2-5 from animal bone, 3-5 to

4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 from garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriae. Found: phosphoric acid, soluble, 4.96; reverted 3.61; insoluble 0.73; total 9.30; available 8.57; nitrogen 0.52; potash 1.99; availability of nitrogen 64; chlorine 6. Remark: Availability of nitrogen too low for materials guaranteed; chlorine excessive.

6556. Big Crop Phosphate. W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; potash 5; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit; 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 2.77; reverted 5.57; insoluble 0.46; total 8.80; available 8.34; potash 5.33; chlorine 3.1. Remark: Chlorine excessive.

6636. Gem Alkaline Phosphate. Seiver Hardware Co., Agent, Keyser, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; potash 3; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit; 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 1.75; reverted 4.94; insoluble 1.19; total 7.88; available 6.69; potash 3.33;chlorine 5.9.

Remark: Chlorine excessive.

6627. High Grade Dissolved Phosphate and Potash. A. G. Chrislip, Agent, Phillippi, W. Va. Guarantee: Phosphoric acid, soluble, 8; reverted 2; insoluble 1; total 11; available 10; potash 5; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit; 1-3 to 2-3 muriate; Found: Phosphoric acid, 6.67; reverted 3.56; insoluble 1.54; total 11.77; available 10.23; potash 5.66; chlorine, 1.5.

6564. High Grade Dissolved Phosphate & Potash. Benson Jacobs, Agent, Little Falls, W. Va. Guarantee. (As above.) Found: Phosphoric acid, soluble 6.47; reverted 3.48; insoluble 1.21; total 11.16; available 9.95; potash 5.29; chlorine 2.4.

6576. Superphosphate. A. G. Chrislip, Agent, Phillippi, W. Va. Guarantee: Phosphoric acid soluble 14; reverted 2; insoluble 1; total 17; available 16. Phosphoric acid from high grade phosphate rock; Found, Phosphoric acid, soluble 14.80; reverted 3.59; insoluble 0.28; total 18.67; available 18.39.

6602. Boss Potash Fertilizer. J. W. Lougherie, Agent, Rowlesburg, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; potash 5; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit; 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 5.28; reverted 3.99; insoluble 0.93; total 10.20; available 9.27; potash 4.93; chlorine 3.9. Remark: Chlorine excessive.

6459. Bradley's Justice Brand Phosphate. Johnson Implement Co., Agent Parkersburg, W. Va. Guarantee. Phosphoric acid, soluble 10, reverted 2; insoluble 1.50; total 13:50; available 12; phosphoric acid from high grade phosphate rock; Found: Phosphoric acid, soluble 7.14; reverted 5.12; insoluble 1.82; total 14.08; available 12.26.

6481. Bradley's Soluble Dissolved Phosphate. A. S. Ford, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2, insoluble 1.50, total 15.50, available 14; phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 12.50, reverted 2.74, insoluble 1.65, total 16.89, available 15.24.

6573. Bradley's Niagara Phosphate. J. W. Lougherie, Agent, Rowlesburg, W. Va. Guarantee: Phosphoric acid, soluble 5; reverted 2; insoluble 1.00; total 8; available 7; nitrogen 0.82; potash 1. Phosphoric acid 1-5 to 2-5 from animal bone, 3-5 to 4-5 from high grade phosphate rock; nitrogen 1-5 to 2-5 from garbage tankage, rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 4.36; reverted 2.95; insoluble 1.47, total 8.78, available 7.31; nitrogen 0.93; potash 1.26; availability of nitrogen 71; chlorine 7.5.

Remark: Chlorine excessive; availability of nitrogen too low for materials guaranteed.

6583. Bradley's Soluble Dissolved Phosphate. E. Shaffer, Agent, Belington, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2, insoluble 1.50, total 15.50, available 14. Phosphoric acid from high grade phosphate rock. Found: Phosphoric acid soluble 12.34; reverted 3.68, insoluble 0.61, total 16.63, available 16.02.

6570. Bradley's Bean and Potato Phosphate. E. Shaffer, Agent, Belington, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1; total 9; available 8; nitrogen .82; potash 4; Phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 from kainit, 1-3 to 2-3 from muriate. Found: Phosphoric acid, soluble 6.07, reverted 2.41, insoluble 1.47, total 9.95, available 8.48, nitrogen 0.97; potash 4.53; availability of nitrogen 72; chlorine 2. Remark: Availibility of nitrogen too low for materials guaranteed.

6603. Bradley's Alkaline Phosphate and Potash. E. Shaffer, Agent, Belington, W. Va. Guarantee. Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10, potash 2; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 7.74, reverted 3.24; insoluble 0.84; total 11.82; available 10.97; potash 2.14; chlorine 6.2. Remark: Chlorine excessive.

6653. Bradley's Corn and Wheat Phosphate. Johnson Implement Co., Agent, Parkersburg, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1.50, total 9.50, available 8; nitrogen 0.82; potash 2; phosphoric acid 1-5 to 2-5 from animal bone, 3-5 to 4-5 from high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 from kainit, 1-3 to 2-3 from muriate. Found: Phosphoric acid, soluble 5.68, reverted 3.52; insoluble 0.94, total 10.14, available 9.20, nitrogen 1.03, potash 2.15; availability of nitrogen 77; chlorine 1. Remark: Availability of nitrogen too low for materials guaranteed.

6528. Canton Chemical Potato and Tobacco Manure, J. W. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2; insoluble 1; total 7; available 6; nitrogen 1. 23; potash 5; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 from kainit, 1-3 to 2-3 from muriate. Found: Phosphoric acid, soluble 4.20, reverted 2.42, insoluble 0.83, total 7.45, available 6.62; nitrogen 1.40; potash 5.25; availability of nitrogen 82; chlorine 2.4.

6529. Canton Chemical Baker's Special Wheat, Corn and Grass Mixture J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric Acid, soluble 7, reverted 2, insoluble 1, total 10; available 9; nitrogen 0.82; potash 2; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage,, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 6.94; reverted 3.22, insoluble 0.75; total 10.91; available 10.16; nitrogen 1.10; potash 2.15; availability of nitrogen 72; chlorine 1.5.

Remark: Availability of nitrogen too low for materials guaranteed.

6530. Canton Chemical Soluble Phosphate and Potash. J. M. Haggerty, Agent, Farmington, W. Va. Guarantee; Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 2; phosphoric acid from high grade phosphate rock, potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 7.03, reverted 3.65, insoluble 0.57, total 11.25, available 10.68, potash 2.20, chlorine 6.7.

Remark: Chlorine excessive.

6531. Canton Chemical Harrow Brand Crop Grower. J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2, insoluble 1, total 9, available 8; nitrogen 0.82; potash 1; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 5.51; reverted 3.06, insoluble 1.48, total 10.05 available 8.57; nitrogen 1.01; potash 1.21; availability of nitrogen 73; chlorine 4.8.

Remark: Availability of nitrogen too low for materials guaranteed; chlorine excessive.

6532. Canton Chemical Baker's Dissolved S. C. Phosphate. J. M. Haggerty, Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 1, total 15; available 14;

phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 12.26; reverted 3.44, insoluble 0.64, total 16.34, available 15.70.

6610. Canton Chemical Game Guano. The Seiver Hardware Co,. Agent, Keyser, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2, insoluble 1; total 9, available 8; nitrogen 1.65; potash 2. Phosphoric acid 1-5 to 2-5 from animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 3-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 6.90, reverted 1,86. insoluable 1.42, total 10.18, available 8.76, nitrogen 1.87; potash 2.10; availability of nitrogen 85; chlorine, 7.

Remarks: Chlorine excessive.

6615. Canton Chemical C. C. C. Special Compound. Leslie Hawker, Agent, Shinnston, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 2.06; potash 6; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 3-5 sulphate of ammonia. Potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 6.72; reverted 1.88; insoluble 1.76; total 10.36; available 8.60; nitrogen 2.24; potash 6.50; availability of nitrogen 88; chlorine 1.3.

6654. Geo. T. Carskadon Special Mixture for Wheat, Oats and Corn. Geo. T. Carskadon, Agent, Keyser, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; potash 2; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 6.38, reverted 2.55, insoluble 0.83, total 9.76, available 8.93; potash 2.54; chlorine 4.6.

Remark: Chlorine excessive.

6580. Cleveland Dryer Horsehead Phosphate. T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10 phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 7.99, reverted 4.04, insoluble 0.37, total 12.40, available 12.03.

6541. Detrick's Standard Potash Fertilizer. R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 4, reverted 2, insoluble 1, total 7, available 6; nitrogen 1.23; potash 5. Phosphoric acid 1-5 to 2-5 from animal bone, 3-5 to 4-5 high grade phosphate rock, nitrogen 1-5 to 2-5 garbage tankage rendered available; 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 4.22; reverted 2.86, insoluble 0.75; total 7.83; available 7.08; nitrogen 1.43; potash 5.10; availability of nitrogen 82; chlorine 2.5.

6507. Detricks P. & B. Special Fertilizer. A. S. Brinkley, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid soluble 10, reverted 2, insoluble 1, total 13, available 12, potash 3. Phosphoric acid from high grade phosphate rock. Potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 8.81; reverted 3.61; insoluble 0.57; total 12.99; available 12.42; potash 3.15; chlorine 3.3.

Remark: Chlorine excessive.

6508. Detrick's Dissolved S. C. Phosphate. A. S. Brinkley, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 1, total 15, available 14; phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 10.29; reverted 2.36, insoluble 1.15, total 15.80, available 14.65.

6509. Detrick's Kangaroo Komplete Kompound. J. M. Miller, Agent Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1 ,total 9, available 8; nitrogen 1.65; potash 3; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock, nitrogen 1-5 to 2-5 garbage tankage rendered available; 1-5 to 2-5 animal tankage, 1-5 to 3-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 5.65, reverted 3.20, insoluble 0.96, total 9.81, available 8.85; nitrogen 1.71; potash 2.86; availability of nitrogen 85; chlorine 2.4.

6625. Great Eastern Soluble Acid Phosphate and Potash.

Farmington Mill Co., Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 2; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 7.08 reverted 3.47, insoluble 0.74, total 11.29, available 10.55; potash 2.22; chlorine 6.2.

Remark: Chlorine excessive.

6526. Great Eastern High Grade Acid Phosphate and Potash. Farmington Mill Company Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 5. Phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 6.91, reverted 3.30, insoluble 1.36, total 11.57, available 10.21; potash 4.91; chlorine 2.6.

6527. Great Eastern Vegetable, Vine and Tobacco Fertilizer. Farmington Mill Company Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2, insoluble 1, total 9, available 8; nitrogen 2.06; potash 3; phosphoric acid 1-5 to 2-5 animal tankage 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available 1-5 to 2-5 animal tankage 1-5 to 3-5 sulphate of ammonia; Potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 6.49; reverted 2.53, insoluble 0.97; total 9.99; available 9.02; nitrogen 2.09; potash 3.20; availability of nitrogen 88; chlorine 2.6.

6634. Great Eastern Japanese Wheat Grower. Farmington Mill Company Agent, Farmington, W. Va. Guarantee: Phosphoric acid, soluble 4; reverted 2, insoluble 1, total 7, available 6; potash 3; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 2.44; reverted 3.67; insoluble 0.96; total 7.07; available 6.11; potash 3.34; chlorine 5.8.

Remark: Chlorine excessive.

6590. Great Eastern Corn Fertilizer. Farmington Mill Company, Agent, Farmington, W. Va. Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 0.82; potash 4; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available; 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia;

potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 5.66; reverted 2.79; insoluble 1.24, total 9.69, available 8.45, nitrogen 1.04, potash 5.03; availability of nitrogen 75; chorine 1.9.

Remark: Availability of nitrogen too low for materials guaranteed.

6575. Lazaretto Dissolved Phosphate. T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 1, total 15, available 14; phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 12.55; reverted 3.51, insoluble 0.40; total 16.46, available 16.06.

6591. Lazaretto Special Potato & Tobacco Fertilizer. T. B. Drummond & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid soluble 6; reverted 2, insoluble 1, total 9, available 8; nitrogen 0.82; potash 4; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia. Potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 5.61, reverted 2.77, insoluble, 1.24, total 9.62, available 8.38, nitrogen 1.14; potash 4.91; availability of nitrogen 77; chlorine 1.9.

Remark: Availability of nitrogen too low for materials guaranteed.

6633. Lazaretto High Grade Dissolved Phosphate and Potash. A. G. Chrislip, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 10, reverted 2, insoluble 1, total 13, available 12; potash 5; phosphoric acid from high grade phosphate rock, potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 6.31; reverted 4.11, insoluble 1.47, total 11.89, available 10.42; potash 5.49; chlorine 2.6.

Remark: Phosphoric acid, low.

6629. Maryland Tornado Fertilizer. Leslie Hawker & Co., Shinnston, W. Va. Guarantee: Phosphoric acid, soluble 10, reverted 2, insoluble 1, total 13, available 12; potash 5, phosphoric acid from high grade phosphate rock, potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 9.44, reverted

3.65, insoluble 1.26, total 14.35, available 13.09; potash 5.87; chlorine 1.8.

6557. Maryland O. K. Ammoniated Frtilizer. W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 0.82; potash 2; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 5.55, reverted 2.91, insoluble 0.79, total 9.25, available, 8.46; nitrogen 0.92; potash 2.63; availability of nitrogen 70; chlorine 3.2.

Remark: Chlorine excessive. Availability of nitrogen too low for material guaranteed.

6558. Maryland Dissolved S. C. Phosphate. W. S. Stout, Agent, Harrisville, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 1, total 15, available 14; phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 12.36, reverted 3.26, insoluble 0.66, total 16.28, availabe 15.62.

6479. Pacific Nobsque Guano. Blue Grass Mill & Supply Co., Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble 1, total, 9, available 8; nitrogen 1.03; potash 2; phosphoric acid 1-5 to 2-5 from animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 5.01; reverted 3.83, insoluble 0.84, total 9.68, available 8.84; nitrogen 1.19; potash 2.45; availability of nitrogen 80; chlorine 4.

Remark: Chlorine excessive.

6515. Reese's High Grade Potash Mixture. Washington, Alexander & Cooke, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 10, reverted 2, insoluble 1, total 13, available 12; potash 5; phasphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble

9.15, reverted 3.67, insoluble 1.21, total 14.03, available 12.82; potash 5.63; chlorine 1.9.

6618. Williams & Clark's Prolific Fertilizer. A. C. Chrislip, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 5, reverted 2, insoluble 1, total 8, available 7; nitrogen .82; potash 1; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muraite. Found: Phosphoric acid, soluble 4.35, reverted 3.16, insoluble 1.43; total 8.94; available 7.51; nitrogen 0.99; potash 1.43; availability of nitrogen 71; chlorine 7.

Remarks: Availability of nitrogen too low for material guaranteed; chlorine excessive.

6463. Williams & Clark's Good Grower Potato Phosphate. W. Howell, Agent, Belington, W. Va. Guarantee: Phosphoric acid, soluble 4, reverted 2, insoluble 1, total 7, available 6; nitrogen 1.23; potash 5. Phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankange rendered available, 1-5 to 2-5 animal tankange, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 4.58, reverted 2.05, insoluble 1.20, total 7.83, available 6.63; nitrogen 1.42; potash 5.46; availability of nitrogen 84; chlorine 2.3.

6625. Williams & Clark's Dissolved Phosphate and Potash, A. G. Chrislip, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2, insoluble 1, total 11, available 10, potash 2, Phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 from kainit, 1-3 to 2-3 from muriate. Found: Phosphoric acid, soluble 7.17, reverted 3.55, insoluble 0.70, total 11.42, available 10.72, potash 2.30, chlorine 6.3.

Remark: Chlorine excessive.

6635. Williams & Clark's Acorn Acid Phosphate. A. G. Chrislip, Agent, Philippi, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 1, total 15, available 14; phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 12.14; reverted 3.56; insoluble 1.16; total 16.86; available 15.70.

6465. Williams & Clark's Royal Phosphate. Wheeling Implement Co., Agent(Wheeling, W. Va. Guarantee: Phosphoric acid,soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 1.03; potash 2; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankange rendered available; 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia. Potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 5.65, reverted 3.24, insoluble 1.14, total 10.03, available 8.89; nitrogen 1.05; availability of nitrogen 62; chlorine 1.8.

Remark: Availability of nitrogen too low for materials guaranteed.

6476. Wheeler's Corn Fertilizer. Lewisburg Supply Co., Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 1.65; potash 2; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 3-5 sulphate of amonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 4.86, reverted 3.95, insoluble 1.05; total 9.86, available 8.81; nitrogen 1.78; potash 2.48; availability of nitrogen 96; chlorine 3.

Remark: Chlorine excessive.

6477. Wheeler's Unammoniated Wheat Grower. Lewisburg Supply Company, Agent Lewisburg, W. Va. Guarantee: Phosphoric acid soluble 10, reverted 2, insoluble 1, total 13, available 12; phosphoric acid from high grade phosphate rock. Found Phosphoric acid, soluble 8.79; reverted 3.56; insoluble, 0.34, total 12.69, available 12.35.

6478. Wheeler's Peerless Acid Phosphate. Lewisburg Supply Company, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 1, total 15, available 14. Phosphoric acid from high grade phosphate rock. Found Phosphoric acid, soluble 11.77; reverted 3.17, insoluble 0.75, total 15.69, available 14.94.

6542. Wheeler's Royal Wheat Grower. Michael Bros., Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 6, rverted 2, insoluble 1, total 9, available 8, nitrogen 1.82, potash 2, phosphoric acid 1-5 to 2-5 animal bone, 2-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 gorbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 5.37, reverted 3.16, insoluble 0.91, total 9.44, available 8.53; nitrogen 0.96; potash 2.25; availability of nitrogen 71; chlorine 3.8.

Remark: Availiability of nitrogen too low for materials guaranteed. Chlorine excessive.

6543. Wheeler's Wheat & Clover Fertilizer. Michael Bros., Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 2. Phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 7.23, reverted 3.43, insoluble 0.63; total 11.29, available 10.66, potash 2.12, chlorine 10.2.

Remark: Chlorine excessive.

6619. Zell's Special Compound for Potatoes and Vegetables. Benson Jacobs, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 2.47; potash 4. Phosphate acid, 1-5 to 2-5 animal bone, 3-4 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 3-5 sulphate of ammonia. Potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 7.83, reverted 2.19, insoluble 1.45, total 11.47, available 10.02; nitrogen 2.05; potash 3.44; availability of nitrogen 84; chlorine 1.4.

6561. Zell's Little Giant. Benson Jacobs, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble 5, reverted 2, insoluble 1, total 8, available 7, nitrogen 0.82, potash 1. Phosphoric acid 1-5 to 2-5 animal bone, 2-5 to 4-5 high grade phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 3.23, reverted 3.87, insoluble 0.85, total 8.65, available 7.80, nitrogen 0.90, potash 1.59; availability of nitrogen 70; chlorine 5.6.

Remark: Availability of nitrogen too low for materials guaranteed. Chlorine excessive.

6562. Zell's Economizer Phosphate. Benson Jacobs, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen, 0.82; potash 2; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock, nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid 7.02; reverted 2.44, insoluble 0.94, total 10.40, available 9.46, nitrogen 1.26; potash 2.42; availability of nitrogen 75; chlorine 1.6.

Remark: Availiability of nitrogen too low for materials guaranteed.

6563. Zell's Eectric Phosphate, Benson Jacobs, Agent, Little Falls, W. Va.. Found: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 2; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 7.08; reverted 3.33, insoluble 0.88, total 11.29, available 10.41, potash 2.43, chlorine 5.3

Remark: Chlorine excessive.

6578. Zell's Dissolved Phosphate. The Exchange Mill Co., Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insolube 1, total 15, available 14. Phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 11.95, reverted 3.46, insoluble 1.47, total 16.88, available 15.41.

6656. Zell's Ammoniated Superphosphate. R. Hunter, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 1.65; potash 2. Phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 high grade phosphate rock, nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 3-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 8.38, reverted 2.63, insoluble 0.47, total 11.48, available 11.01, nitrogen none; potash 5.53; chlorine 1.3.

Remark: Not as guaranteed, nitrogen absent, phosphoric acid high, potash high.

ATLANTIC FERTILIZER COMPANY, BALTIMORE, MARYLAND.

6488. Atlantic Standard Compound, J. S. Hanna, Agent, Spring Creek. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 1.65; potash 2; phosphoric acid from acid phosphate and dissolved bone tankage; nitrogen from sulphate of ammonia 1-3, bone tankange 2-3; potash from kainit. Found: Phosphoric acid, soluble 2.77, reverted 7.32, insoluble 0.99, total 11.08, available 10.09; nitrogen 1.41; potash 2.65; availability of nitrogen 81; chlorine 2.5.

Remark: Nitrogen low.

6489. Matchelss A. B. C. Food. J. S. Hanna, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 0.41; potash 3; phosphoric acid from acid phosphate and dissolved bone tankage; nitrogen from bone tankage; potash from manure salt. Found: phosphoric acid, soluble 4.77, reverted 4.38, insoluble 0.42, total 9.57, available 9.15; nitrogen 1.55; potash 4; availability of nitrogen 80; chlorine 2.2.

6490. Atlantic Dissolved Phosphates. J. S. Hanna, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid, soluble 11, reverted 3, insoluble 1, total 15, available 14. Phosphoric acid from Dissolved Florida Phosphate. Found: Phosphoric acid, soluble 8.98, reverted 5.98, insoluble 2.49, total 17.45, available 14.96.

6491. Gold Medal Superior for All Crops. J. S. Hanna, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 1.65; potash 3. Phosphoric acid from acid phosphate and dissolved bone tankage; nitrogen from sulphate of ammonia 1-3, bone tankage 2-3; potash from manure salt. Found: Phosphoric acid, soluble 4.18, reverted 5.42, insoluble 1.48, total 11.08, available 9.60, nitrogen 1.67, potash 3.66; availability of nitrogen 83; chlorine 2.3.

6492. Arrow Brand Special. J. S. Hanna, Agent, Spring

Creek, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 0.82; potash 4; phosphoric acid from acid phosphate and dissolved bone tankage; nitrogen from bone tankage; potash 2-3 muriate, 1-3 kainit. Found: Phosphoric acid, soluble, 4.91, reverted 5.69, insoluble 0.50, total 11.10, available 10.60, nitrogen 1.01; potash 3.65; availability of nitrogen 69; chlorine 2.1.

Remark: Potash low.

6493. Jumbo Crop Grower. J. S. Hanna, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8, potash 5. Phosphoric acid from dissolved Florida phosphate; potash 2-3 muriate, 1-3 kainit. Found: phosphoric acid soluble 1.05, reverted 8.07, insoluble 3.15, total 12.27, available 9.12, potash 5.98; chlorine 2.

6651. Atlantic Crop Producer. T. P. Liklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 0.41; potash 2. Phosphoric acid from acid phosphate and dissolved bone tankage; nitrogen from bone tankage; potash from kainit. Found: Phosphoric acid, soluble 4.21, reverted 4.52, insoluble 1.65, total 10.38, available 8.73 nitrogen 0.64, potash 2.87, availability of nitrogen 70; chlorine 3.4.

ARMOUR FERTILIZER WORKS, BALTIMORE, MD.

6454. Raw Bone Meal. Submitted for analysis by J. H. Miller, Paw Paw, W. Va. Guarantee: Phosphoric acid, reverted 10, insoluble 12, total 22, available 10; nitrogen 3.70; phosphoric acid from bone; nitrogen from bone. Found: Phosphoric acid total 22.69, nitrogen 3.71; availability of nitrogen 72.

6455. Fruit and Root Crop Special. Submitted for analysis by H. W. Miller, Paw Paw, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 0.50, total 8.50, available 8; nitrogen 1.65; potash 5. Phosphoric acid 1-5 to 2-5 from bone tankage, 3-5 to 4-5 acid phosphate; nitrogen 1-10 to 2-10 bone tankage, 8-10 to 9-10 animal tankage; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate of potash. Found: Phosphoric acid souble 6.40, reverted

2.16, insoluble 0.57, total 9.13, available 8.56; nitrogen 1.66; potash 5.63; availability of nitrogen 90; chlorine 2.5.

6482. Bone, Blood & Potash, A. S. Ford, Agent, Lewisburg, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 0.50, total 8.50, available 8; nitrogen 4.11; potash 7. Phosphoric acid 1-5 to 2-5 from bone tankage, 3-5 to 4-5 acid phosphate; nitrogen 1-5 to 2-5 blood and nitrate of soda, 3-5 to4-5 bone tankage and animal tankage. Potash 1-5 to 2-5 sulphate of potash, 3-5 to 4-5 muriate of potash. Found: Phosphoric acid, soluble 7.21, reverted 2.19, insoluble 0.23, total 9.63, available 9.40, nitrogen 3.27, potash 9.05; availability of nitrogen 94; chlorine 0.9.

Remark: Nitrogen very low.

6510. Grain Grower, J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 0.50, total 8.50, available 8.00; nitrogen 1.65; potash 2; phosphoric acid 1-5 to 2-5 bone tankage, 3-5 to 4-5 acid phosphate; nitrogen 1-10 to 2-10 bone tankage, 8-10 to 9-10 animal tankage; potash from kainit. Found: Phosphoric acid, soluble 5.96; reverted 3.14, insoluble, 0.26, total 9.36, available 9.10; Nitrogen 0.95; potash 2.43; availability of nitrogen 76; chlorine 2.3.

Remark: Nitrogen very low.

6511. Royal Ammoniated Bone. Spring Crek Milling Co., Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2;insoluble 0.50; total 8.50, available 8; nitrogen 0.82; potash 4; phosphoric acid 1-5 to 4-5 from bone tankage, 3-5 to 4-5 from acid phosphate; nitrogen 1-5 to 2-5 bone tankage, 3-5 to 4-5 animal tankage; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriat of potash. Found: Phosphoric acid, soluble 6.10, reverted 2.17. insoluble 0.11, total 8.38, available 8.27, nitrogen 0.83, potash 3.65; availability of nitrogen 81; chlorine 2.3.

Remark: Potash low.

6534. Phosphate and Potash No. 1. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 0.50, total 10.50, available 10; potash 2. Phosphoric acid form acid phosphate; potash from kainit. Found: Phosphoric acid, soluble 9.15; reverted 1.40, insoluble 0.20, total 10.75, available 10.55; potash 2.35; chlorine 2.3.

6535. Phosphate and Potash No. 2. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 6; reverted 2; insoluble .50, total 8.50, available 8; potash 5; phosphoric acid from acid phosphate; potash 1-3 to 2-3 from muriate of potash, 1-3 to 2-3 from kainit. Found: Phosphoric acid, soluble 4.75; reverted 3.37, insoluble 0.91, total 9.03, available 8.12, potash 4.97, chlorine 3.6.

Remark: Chlorine excessive.

6620. High Grade Potato. W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 0.50, total 8.50, available 8; nitrogen 1.65; potash 10. Phosphoric acid 1-5 to 2-5 bone tankage, 3-5 to 4-5 acid phosphate; nitrogen 1-10 to 2-10 bone tankage, 8-10 to 9-10 animal tankage; potash 1-5 to 2-5 sulphate of potash, 3-5 to 4-5 muriate of potash. Found: Phosphoric acid, soluble 6.20, reverted 2.63, insoluble 0.79, total 9.62, available 8.83; nitrogen 1.60; potash 10.54; availability of nitrogen 89; chlorine 0.8.

6536. High Grade Potato. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee (as above). Found: Phosphoric acid, soluble 6.06, reverted, 2.97, insoluble 0.42, total 9.45, available 9.03, nitrogen 1.59; potash 10.24; availability of nitrogen 89; chlorine 1.2.

6537. Star Phosphate, R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 0.50, Total 14.50; available 14; phosphoric acid from acid phosphate. Found: phosphoric acid, soluble 13.48, reverted 1.60, insoluble 0.19, total 15.27, available 15.08.

6617. Royal Ammoniated Bone. W. H. Bailey & Son, Agent, Morgantown, W. Va. Guaranteed: Phosphoric acid, soluble 6, reverted 2, insoluble 0.50, total 8.50, available 8; nitrogen 0.82; potash 4; phosphoric acid 1-5 to 4-5 from bone tankage, 3-5 to 4-5 from acid phosphate; nitrogen 1-5 to 2-5 bone tankage, 3-5 to 4-5 tankage; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate of potash. Found: Phosphoric acid, soluble 6.53, reverted 1.58, insoluble 0.27, total 8.38, available 8.11, nitrogen 0.87; potash 4.21; availability of nitrogen 79; chlorine 3.2.

Remark: Chlorine excessive.

6624. Potash Mixture, W. H. Bailey, & Son, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 4.50, reverted 1.50, insoluble 0.50, total 6.50, available 6; potash 3; phosphoric acid from acid phosphate; potash from kainit. Found: Phosphoric acid, soluble 4.16, reverted 1.80, insoluble 0.23, total 6.19, available 5.96; potash 3.11; chlorine 3.

6632. Bone Meal. W. H. Bailey & Son, Agent, Morgantown. W. Va. Guarantee: Phosphoric acid, reverted 10, insoluble 14, total 24, available 10; nitrogen 2.47; phosphoric acid from bone; nitrogen from bone. Found: Phosphoric acid total 25.33; nitrogen 2.83; availability of nitrogen 91.

6650. Crop Grower, Seiver Hardware Co., Agent, Keyser, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 0.50; total 8.50; available 8; nitrogen 0.82; potash 2; phosphoric acid 1-5 to 2-5 bone tankage, 3-5 to 4-5 acid phosphate; nitrogen 1-5 to 2-5 bone tankage, 3-5 to 4-5 animal tankage, potash from kainit. Found: Phosphoric acid, soluble 5.04, reverted 3.87, insoluble 0.64, total 9.55, available 8.91; nitrogen 0.84, potash 2.21; availability of nitrogen 63; chlorine 3.4.

6669. Wheat and Clover. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 8; reverted 2, insoluble 0.50, total 10.50, available 10; potash 5; phosphoric acid from acid phosphate; potash 1-3 to 2-3 muriate of potash, 1-3 to 2-3 kainit. Found: Phosphoric acid, soluble 5.41, reverted 4.01; insoluble 0.48, total 9.90, available 9.42; potash 6.68; chlorine 2.5.

Remark:—Phosphoric acid, low.

6611. Genuine German Kainit. T. B. Drummond & Co., Agent, Buckhannon, W. Va. (Not registered this year.) Guarantee: Potash 12; potash from Kainit. Found: Potash 12.91; chlorine 2.8.

BAUGH & SONS CO., PHILADELPHIA, PA., AND NORFOLK, VA.

6550. Baugh's Double Eagle Twenty-Five Dollar Phosphate. John Krepps, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 10.50, available 8.50; nitrogen 1.65; potash 1; phosphoric acid from phosphate rock; nitrogen 2-3 from animal tankage, 1-3 from sulphate of ammonia; potash from kainit. Found: Phosphoric acid, soluble 3.61, reverted 6.34, insoluble 1.48, total 11.43, available 9.95, nitrogen 1.90; potash 1.54; availability of nitrogen 87; chlorine 2.5.

6549. Baugh's Soluble Alkaline Super Phosphate. John Krepps, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, insoluble 1, total 11, available 10; potash 2; phosphoric acid from dissolved rock phosphate; potash from kainit. Found: Phosphoric acid, soluble 1.57; reverted 9.04, insoluble 1.48, total 12.09, available 10.61, potash 2.09; chlorine 3.9.

Remark: Chlorine excessive

6551. Baugh's General Crop Grower for All Crops. John Krepps, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 10, available 8; nitrogen 0.823; potash 1; phosphoric acid from phosphate rock; nitrogen 1-2 from animal tankage, 1-2 from garbage tankage; potash from kainit. Found: Phosphoric acid, soluble 2.10; reverted 7.06; insoluble 1.48, total 10.64, available 9.16, nitrogen 0.94; potash 1.13; availability of nitrogen 72; chlorine 3.

6605. Baugh's Animal Base and Potash Compound for All Crops. George Carskaddon, Agent, Keyser, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 10, available 8, nitrogen 1.65; potash 2; phosphoric acid from phosphate rock; nitrogen 2-3 from animal tankage, 1-3 from sulphate of ammonia; potash 1-2 from muriate of potash, 1-2 from kainit. Found: Phosphoric acid, soluble 4.07, reverted 2.12, insoluble 1.08, total 7.27, available 6.19, nitrogen 1.91; potash 10.68; availability of nitrogen 88; chlorine 1.6.

Remark:—Not as guaranteed.

6552. Baugh's Animal Base and Potash Compound for All Crops. John Krepps, Agent, Morgantown, W. Va. Guarantee: (As above.) Found: Phosphoric acid, soluble 3.60, reverted 3.12, insoluble 0.59, total 7.31, available 6.72; nitrogen 1.66; potash 10.41; availability of nitrogen 88; chlorine 1.3.

Remark:—Not as guaranteed.

6553. Baugh's 16% Acid Phosphate. John Krepps, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, insoluble 1, total 17, available 16. Phosphoric acid from dissolved rock phosphate. Found: Phosphoric acid soluble 15.03, reverted 2.49, insoluble 0.15, total 17.67, available 17.52.

6574. Baugh's Special Potato Manure. Arch Fleming, Agent, Fairmont, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 7, available 5; nitrogen 1.65; potash 10; phosphoric acid from phosphate rock; nitrogen 2-3 from animal tankage, 1-3 from sulphate of ammonia; potash from muriate of potash. Found: Phosphoric acid soluble 4.50, reverted 1.86; insoluble 0.94, total 7.30, available 6.36, nitrogen 1.80; potash 10.40; availability of nitrogen 91; chlorine 1.6.

6593. Baugh's Excelsior Guano. Conaway & Clayton, Agent, Barracksville, W. Va. Guarantee: Phosphoric acid, insoluble 2; total 10, available 8, nitrogen .823; potash 4; phosphoric acid from phosphate rock; nitrogen 1-2 from animal tankage, 1-2 from garbage tankage; potash 1-2 from kainit, 1-2 from muriate of potash. Found: phosphoric acid, soluble 7.09, reverted 2.21, insoluble 0.79, total 10.09, available 9.30, nitrogen 0.96, potash 4.36, availability of nitrogen 81; chlorine 2.3.

6606. Baugh's Peruvian Guano Substitute for Potatoes and all Vegetables. Arch Fleming, Agent, Fairmont, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 8, available 6; nitrogen 4.12; potash 7; phosphoric acid from phosphate rock; nitrogen 1-2 from animal tankage, 1-2 from sulphate of ammonia; potash from muriate of potash. Found: Phosphoric acid, soluble 5.22; reverted 1.71, insoluble 0.70, total 7.63, available 6.93; nitrogen 4.53; potash 6.96; availability of nitrogen 92; chlorine 1.3.

6607. Baugh's Complete Animal Base Fertilizer. Arch Fleming, Agent, Fairmont, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 10, available 8; nitrogen 1.65; potash 5; phosphoric acid from phosphate rock; nitrogen 2-3 from animal tankage, 1-3 from sulphate of ammonia. Potash 1-2 from muriate of potash, 1-2 from kainit. Found: Phosphoric acid, soluble 6.90, reverted 2.16, insoluble 1.12, total 10.18, available 9.06; nitrogen 1.93, potash 5.54, availability of nitrogen 90. Chlorine. 1.5.

6608. Baugh's Export Bone with Potash. John Krepps, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, total 11; nitrogen 1.65; potash 2; phosphoric acid from animal bone; nitrogen from animal bone; potash 1-2 from muriate of potash, 1-2 from kainit. Found: Phosphoric acid total 15.10; nitrogen 1.54; potash 2.37; availability of nitrogen 90; chlorine 3.2.

Remark:—Chlorine excessive.

6609. Baugh's Ammoniated Soluble Alkaline. Offutt & Lakin, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 10, available 8; nitrogen 0.411; potash 2; phosphoric acid from phosphate rock; nitrogen from garbage tankage; potash 1-2 from muriate of potash, 1-2 kainit. Found: Phosphoric acid, soluble 2.45, reverted 9.08, insoluble 1.12, total 12.65, available 11.53; nitrogen 0.22; potash 2.25; chlorine 4.5.

Remark:—Nitrogen low; chlorine excessive.

6613. Baugh's Pure Dissolved Animal Bone. George Carskadon, Agent, Keyser, W. Va. Guarantee: Phosphoric acid, insoluble 3, total 16, available 13; nitrogen 2.06; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, soluble 1.34, reverted 12.73, insoluble 3.76, total 17.83, available 14.07; nitrogen 2.37; availability of nitrogen 87.

6628. Baugh's Raw Bone Meal Warranted Pure. John Krepps, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, total 21.50; nitrogen 3.70; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 21.29; nitrogen 3.62; availability of nitrogen 78.

Remark:—Phosphoric acid, low.

6641. Baugh's Peninsula Grain Producer. G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 10, available 8; nitrogen 1; potash 2; phosphoric acid from phosphate rock; nitrogen 1-2 animal tankage, 1-2 garbage tankage; potash 1-2 muriate of potash, 1-2 kainit. Found: Phosphoric acid, soluble 2.58; reverted 7.41; insoluble 5.22, total 15.21, available 9.99; nitrogen 1.38; potash 3.64; availability of nitrogen 80; chlorine 3.

Remark:—Chlorine excessive.

6655. Baugh's 12 & 5 Phosphate and Potash. J. Newbraugh, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, insoluble 1, total 13, available 12; potash 5; phosphoric acid from dissolved rock phosphate; potash 1-2 from muriate of potash, 1-2 from kainit. Found: Phosphoric acid, soluble 9.35, reverted 2.81, insoluble 0.91, total 13.07, available 12.16; potash 4.64; chlorine 1.5.

Remark:—Potash low.

6657. Baugh's Fine Ground Bone. T. P. Licklider, Agent, Martinsburg, W. Va. (Not registered this year.) Guarantee: Phosphoric acid total 22.90; nitrogen 2.47; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 17.91; nitrogen 3.37; availability of nitrogen 89.

Remark:—Phosphoric acid, low.

6658. Baugh's Fine Ground Bone. G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid 16.49, nitrogen 2.47, phosphoric acid from animal bone, nitrogen from animal bone. Found: Phosphoric acid, total 16.10; nitrogen 2.58; availability of nitrogen 82.

Remark:—Phosphoric acid, low.

6659. Baugh's 10 and 8 Phosphate and Potash. J. Newbraugh, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, insoluble 1, total 11, available 10; potash 8; phosphoric acid from dissolved rock; potash 1-2 from muriate of potash, 1-2 from kainit. Found: Phosphoric acid, soluble 5.89; reverted 2.34; insoluble 1.39; total 9.62; available 8.23; potash 2.16; chlorine 2.8.

Remark:—Phosphoric acid, low. Potash, low. Not as guaranteed.

6660. Baugh's High Grade Potash Mixture. J. Newbraugh, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, insoluble 1, total 11, available 10; potash 4; phosphoric acid from dissolved rock phosphate; potash 1-2 from muriate of potash, 1-2 from kainit. Found: Phosphoric acid, soluble 7.99; reverted 1.65; insoluble 1.06; total 11.70; available 10.64; potash 4.09; chlorine 2.9.

BOWKER FERTILIZER COMPANY, BOSTON AND NEW YORK.

6506. Bowker's Corn and Grain Grower. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 0.82; potash 4; Phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 phosphate rock, nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 6.10, reverted 2.44, insoluble 0.43, total 8.97, available 8.54; nitrogen 0.94; potash 4.19, availability of nitrogen 87; chlorine 2.2.

6560. Bowker's Soluble Phosphate. W. F. Siller, Agent, Pennsboro, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 1, total 15, available 14. Phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 11.82, reverted 3.66, insoluble 1.56, total 17.04, available 15.48.

6582. Bowker's Soluble Phosphate. John W. Dodge, Agent, Terra Alta, W. Va. Guarantee: (As above.) Found: Phosphoric acid, soluble 12.03, reverted 3.75, insoluble 1.26, total 17.04, available 15.78.

6594. Bowker's 10 per cent Manure. Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, soluble 4, reverted 1, insoluble 1, total 6, available 5; nitrogen 0.82; potash 10; phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 3.95, reverted 1.73, insoluble 0.99, total 6.67, available 5.68, nitrogen 0.98; potash 12.91; availability of nitrogen 81; chlorine 1.4.

6614. Bowker's Farm and Garden Fertilizer. John W. Dodge, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 1.65; potash 2; phosphoric acid 1-5 to 2-5 from animal bone, 3-5 to 4-5 from phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 3-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 6.88, reverted 2.02, insoluble 1.36, total 10.26, available 8.60, nitrogen 1.86; potash 2.19; availability of nitrogen 87; chlorine 4.2.

Remark:—Chlorine excessive.

6621. Bowker's Harvest Bone. Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 0.82; potash 1. Phosphoric acid 1-5 to 2-5 animal bone, 3-5 to 4-5 phosphate rock; nitrogen 1-5 to 2-5 garbage tankage rendered available, 1-5 to 2-5 animal tankage, 1-5 to 2-5 sulphate of ammonia; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid, soluble 5.63, reverted 2.47, insoluble 1.93, total 10.03, available 8.10; nitrogen 1; potash 1.30; availability of nitrogen 72; chlorine 6.6.

Remark:—Availability of nitrogen too low for materials guaranteed. Chlorine excessive.

6622. Bowker's Dissolved Bone and Potash. John W. Dodge, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 2; phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 kainit, 1-3 to 2-3 muriate. Found: Phosphoric acid soluble 7.45; reverted 3.67, insoluble 0.59, total 11.71, available 11.13; potash 2.32; chlorine 5.7.

Remark:—Chlorine excessive.

6630. Bowker's Bone Meal. Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, total 25; nitrogen 1.23; phosphoric acid from animal bone; nitrogen from animal bone. Found: Phosphoric acid, total 15.42; nitrogen 1.91; availibility of nitrogen 84.

Remark:—Phosphoric acid, low.

6631. Bowker's Potash Fertilizer. Orie Myers, Agent, Clarksburg, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10, potash 5, phosphoric acid from high grade phosphate rock; potash 1-3 to 2-3 muriate, 1-3 to 2-3 kainit. Found: Phosphoric acid, soluble 6.51, reverted 3.63, insoluble 1.63, total 11.97, available 10.34; potash 4.98; chlorine 2.5.

CHESAPEAKE CHEMICAL COMPANY, BALTIMORE, MD.

6586. Long's Mixture. L. M. Long, Agent, Rippon, W. Va. Guarantee: Phosphoric acid, soluble 11.50, reverted 1.50, insoluble 1.50, total 14.50, available 13; nitrogen 1.23; potash 2.50; phosphoric acid from Florida pebble rock; nitrogen 1-2 from 16 per cent blood, 1-2 from dissolved animal bone; potash from muriate of potash. Found: Phosphoric acid, soluble 11.29, reverted 1.59, insoluble 0.41, total 13.29; available 12.88; nitrogen 1.42; potash 2.71; availability of nitrogen 65; chlorine 0.8.

GRIFFITH & BOYD CO., BALTIMORE, MD.

6664. XX Potash Manure. H. C. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 3, insoluble 1, total 11, available 10, potash 5, phosphoric acid from S. C. Rock; potash 1-2 muriate of potash 1-2 kianit. Found: Phosphoric acid, soluble 5.33, reverted 5.97, insoluble 1.88, total 13.18, available 11.30; potash 5.08. Chlorine 1.9.

6637. XX Potash Manure. T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee. (As Above). Found: Phosphoric acid, soluble 1.86, reverted 8.02; insoluble 2.42, total 12.30, available 9.88; potash 5.57; chlorine 1.9.

6665. Special Grain Grower. J. K. Boyles, Agent Inwood, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 3, insoluble, 1, total 11, available 10; potash 2; phosphoric acid from S. C. Rock; potash from kainit. Found: Phosphoric acid, soluble 4.69, reverted 6.23, insoluble 1.48, total 12.40, available 10.92, potash 2.28; chlorine 3.5.

6666. Gem Phosphate, H. C. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid, soluble 5, reverted 1.50, insoluble 0.50, total 7, available 6.50, potash 3; phosphoric acid from S. C. Rock, potash from kainit; Found: Phosphoric acid, soluble 0.56, reverted 5.77, insoluble 4.04, total 10.37, available 6.33, potash 2.88, chlorine 3.5.

6533. Farmer's Potato Manure, T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 1, insoluble 1, total 9, available 8, nitrogen 0.85, potash 9, phosphoric acid from S. C. Rock 1-3, low grade bone tankage 1-3, dissolved bone 1-3; nitrogen from low grade bone tankage 1-3, dissolved bone 1-3, fish 1-3; potash from muriate of potash 1-2, sulphate of potash 1-4, kainit 1-4. Found: Phosphoric acid, soluble 4.64, reverted 4.50, insoluble 2.10, total 11.24, available 9.14; nitrogen 1.34; potash 9.83; availability of nitrogen 78; chlorine 9.

HUBBARD FERTILIZER CO., BALTIMORE, MD.

6638. Hubbard's Oriental Phosphate. H. C. Cooper & Son, Agent, Romney, W. Va. Guarantee: Phosphoric acid, 6.75; reverted 1.25; insoluble 1.75; total 9.75; available 8; nitrogen 0.82; potash 2; phosphoric acid from phosphate rock; nitrogen 3-4 from animal tankage, 1-4 from garbage tankage; potash all from manure salts. Found: Phosphoric acid, soluble 0.48, reverted 7.61, insoluble 0.64, total 8.73, available 8.09; nitrogen 1.12; potash 2.25; availability of nitrogen 61 chlorine 1.3.

6643. Hubbard's 14% Phosphate. G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid, soluble 12; reverted 2, insoluble 2, total 16, available 14; phosphoric acid from phosphate rock. Found: Phosphoric acid soluble 14.71, reverted 2.69, insoluble 0.31, total 17.71, available 17.40.

6670. Hubbard's 14% Phosphate. G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble 5.29, reverted 6.39, insoluble 0.99, total, 12.67, available 11.68.

JARECKI CHEMICAL COMPANY, CINCINNATI, OHIO...

6504. No. 1 Guano with Phosphate and Potash. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 0.82; potash 2; phosphoric acid from mineral phosphate, bone and animal tankage; nitrogen from animal tankage; potash from muriate; Found: Phosphoric acid, soluble 5, reverted 4.52; insoluble 0.94, total 10.46, available 9.52, nitrogen 0.93, potash 2.47, availability of nitrogen 79; chlorine 0.9.

T. P. LICKLIDER, MARTINSBURG, W. VA.

6644. Licklider's Wheat Fertilizer, T. P. Licklider, Agent, Martinsburg, W. Va. Guarantee; Phosphoric acid, soluble 6, reverted 4, insoluble 1, total 11, available 10, potash 2, phosphoric acid from phosphate rock, potash from kainit. Found: Phosphoric acid, soluble 8.73, reverted 3.75, insoluble 1.28, total 13.76, available 12.48; potash 1.85; chlorine 3.

MARIETTA BONE & PHOSPHATE CO., MARIETTA, OHIO.

6467. Mile Run Fertilizers, Pure Raw Bone. C. H. Becker, Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, total 20; nitrogen 3.50; phosphoric acid from bone; nitrogen from bone. Found: Phosphoric acid 19.40; nitrogen 3.42; availability of nitrogen 75.

Remark: Phosphoric acid low.

6468. Mile Run Fertilizers, Acid Phosphate. C. F. Braunlich, Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 14, available 12; phosphoric acid from acid phosphate; Found: Phosphoric acid, soluble 8.46, reverted 3.44, insoluble 0.42, total 12.32, available 11.90.

6469. Mile Run Fertilizers, Potato and Truck Special, C. H. Becker, Agent, Wheeling, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 10, available 8; nitrogen 2.05; potash 6. Phosphoric acid 1-4 from animal tankage, 3-4 acid phosphate. Nitrogen 1-2 from animal tankage, 1-2 from nitrate of soda; potash 1-2 from sulphate, 1-4 from muriate and 1-4 from kainit. Found: Phosphoric acid, soluble 3.55, reverted 5.40, insoluble 1.33, total 10.28, available 8.95, nitrogen 1.92, potash 5.36; availability of nitrogen 91, chlorine 1.0.

MILLER FERTILIZER COMPANY, BALTIMORE, MD.

6460. Acid Phosphate. Thomas Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble 10, reverted 4, insoluble 0.50, total 14.50, available 14; phosphoric acid from phosphate rock. Found: Phosphoric acid, soluble 12.78, reverted 3.10, insoluble 0.83, total 16.71, available 15.88.

6461. Potato and Vegetable Grower. Thomas Nuzum, Agent.

Grafton, W. Va. Guarantee: Phosphoric acid, soluble 5, reverted 3, insoluble 0.50, total 8.50, available 8; nitrogen 1.65; potash 4; phosphoric acid 1-3 from bone tankage, 2-3 from acid phosphate; nitrogen 1-3 from sulphate of ammonia, 2-3 from bone tankage; potash from manure salt; Found: Phosphoric acid, soluble 6.24; reverted 2.85, insoluble 0.66, total 9.75; available 9.09; nitrogen 1.88; potash 4.45; availability of nitrogen 90; chlorine 2.3.

6462. Club Brand, Thomas Nuzum, Agent, Grafton, W. Va. Guarantee: Phosphoric acid, soluble 5, reverted 3, insoluble 0.50, total 8.50, available 8; nitrogen 0.42; potash 2; phosphoric acid, 3-20 bone and slaughter house tankage, 1-20 garbage tankage, 4-5 acid phosphate; nitrogen 1-2 bone and slaughter house tankage, 1-2 garbage tankage; potash 1-2 kainit, 1-2 manure salts. Found: Phosphoric acid, soluble 4.82; reverted 3.63, insoluble 0.52; total 8.97; available 8.45; nitrogen 0.42; potash 2.83; availability of nitrogen 66; chlorine 2.8.

6470. Hustler Phosphate. Gay & McLaughlin, Agent, Marlinton: Guarantee: Phosphoric acid, soluble 5, reverted 3, insoluble 0.50; total 8.50, available 8; nitrogen 0.83; potash 1; phosphoric acid 3-20 from bone and slaughter house tankage, 1-20 from garbage tankage, 4-5 acid phosphate; nitrogen 1-5 from sulphate of ammonia, 2-5 bone and slaughter house tankage, 2-5 garbage tankage; potash from kainit. Found: Phosphoric acid, soluble 4.97; reverted 3.62; insoluble 0.40, total 8.99, available 8.59; nitrogen 0.97; potash 1.41; availability of nitrogen 81. chlorine 2.4.

6471. M. B. S. Gay & McLaughlin, Agent, Marlinton, W. Va. Guarantee: Phosphoric acid, soluble 5, reverted 2; insoluble 0.50; total 7.50, available 7; nitrogen 0.83; potash 3; phosphoric acid 3-20 from bone and slaughter house tankage, 1-20 garbage tankage, 4-5 acid phosphate; nitrogen 1-5 sulphate of ammonia, 2-5 bone and slaughter house tankage, 2-5 garbage tankage; potash from manure salt. Found: Phosphoric acid, soluble 3.85, reverted 3.47, insoluble 0.36, total 7.68, available 7.32, nitrogen 0.98; potash 3.40; availability of nitrogen 80; chlorine 2.8.

Remark: Chlorine excessive.

6676. Acid Phosphate. C. L. Rice, Agent, Berkeley Springs, W. Va. Guarantee: Phosphoric acid, soluble 10, reverted 4, insoluble 0.50, total 14.50, available 14; phosphoric acid from acid phosphate. Found: Phosphoric acid, soluble 8.64; reverted 7.14; insoluble 0.85; total 16.62; available 15.77.

6503. Clinch Phosphate. Spring Creek Milling Co., Spring Creek, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 3, insoluble 0.50, total 10.50, available 10; potash 2; phosphoric acid from acid phosphate; potash from kainit. Found: Phosphoric acid, soluble 4.18, reverted 6.51, insoluble 0.22, total 10.91, available 10.69; potash 2.77 chlorine 2.5.

D. B. MARTIN COMPANY, PHILADELPHIA, BALTIMORE AND MONTREAL, CANADA.

6639. Martins Pure Bone & Potash Compound (Bull Head) Washington, Alexander & Cook, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 6, insoluble 10, total 16; nitrogen 1.65; potash 2.50; phosphoric acid from pure animal bone, nitrogen from pure animal bone; potash from muriate of potash. Found: Phosphoric acid, soluble trace, reverted 9.06, insoluble 14.16, total 23.19, available 9.03, nitrogen 1.72; potash 2.02; availability of nitrogen 91; chlorine 3.

Remark: Chlorine excessive. Potash, low.

6645. Martin's Pure Raw Bone Meal (Bull Head.) Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, total 22; nitrogen 3.71; phosphoric acid from pure raw bone; nitrogen from pure raw bone. Found: Phosphoric acid, total 23.31; nitrogen 4.20; availability of nitrogen 88.

6652. Martin's Sure Grower (Bull Head) W. N. Lemon & Son, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid, soluble 4, reverted 4, insoluble 2, total 10, available 8; nitrogen 0.83; potash 1; phosphoric acid 1-2 from bone tankage, 1-2 from phosphate rock; nitrogen from bone tankage; potash from kainit. Found: Phosphoric acid, soluble 5.46, reverted 3.38, insoluble 1.65, total 10.49, available 8.84, nitrogen 1.10; potash 0.77; availability of nitrogen 77; chlorine 3.

6663. Martin's Potash and Soluble Bone (Bull Head). W. N. Lemon & Son, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid soluble 6, reverted 4, insoluble 1, total 11, available 10; potash 2; phosphoric acid from phosphate rock; potash from kainit.

Found: Phosphoric acid, soluble 3.83, reverted 6.09, insoluble 1.91; total 11.83, available 9.92; potash 3.10; chlorine 1.1.

G. OBER & SONS COMPANY, BALTIMORE, MD.

6512. Ober's Dissolved Bone Phosphate. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 11, reverted 3, insoluble 1, total 15, available 14; phosphoric acid from high grade Florida phosphate. Found: Phosphoric acid, soluble 11.63, reverted 2.76, insoluble 0.14, total 14.53, available 14.39.

6538. S. & S. Special Wheat Compound. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 2, insoluble 2, total 11, available 9; nitrogen 0.82; potash 2; phosphoric acid from high grade Florida phosphate 8-9, bone from tankage and fish 1-9; nitrogen from high grade bone and blood tankage 1-2 to 3-4, from fish 1-2 to 3-4; potash from sulphate of potash. Found: Phosphoric acid, soluble 6.75, reverted 3.37, insoluble 1.19, total 11.31, available 10.12; nitrogen 1.40; potash 1.87; availability of nitrogen 89; chlorine 1.8.

Remark: Chlorine excessive.

6539. Ober's High Grade Acid Phosphate. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 14.50, reverted 1.50, insoluble 1, total 17, available 16; phosphoric acid from High Grade Florida phosphate. Found: Phosphoric acid soluble 16.35, reverted 3.23, insoluble 0.33, total 19.91, available 19.58.

6540. Ober's Standard Potash Compound. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 10; reverted 2, insoluble 1, total 13, available 12; potash 5; phosphoric acid from high grade Florida phosphate; potash from muriate of potash; Found: Phosphoric acid, soluble 9.02, reverted 3.95, insoluble 1.35, total 14.32, available 12.97; potash 5.26; chlorine 1.5.

6587. Special Mixture for Wheat. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 2, insoluble 2, total 11, available 9; nitrogen 0.82; potash 2; phosphoric acid from high grade Florida phosphate 8-9, bone from tankage and fish 1-9; nitrogen form high grade bone and blood tankage 1-2 to 3-4, fish 1-2 to 3-4; potash from sulphate of potash. Found: Phosphoric acid, soluble 6.89, reverted 2.05, insoluble 1.93, total 10.87, available 8.94; nitrogen 0.90; potash 2.59; availability of nitrogen 90; chlorine 2.3.

Remark: Chlorine excessive.

6640. Ober's Ox Head Mixture. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 0.41, potash 2; phosphoric acid from high grade Florida phosphate; nitrogen from high grade bone and blood tankage 1-4 to 1-2, fish 1-4 to 1-2; potash from sulphate of potash. Found: Phosphoric acid, soluble 7.25; reverted 2.11; insoluble 2.08; total, 11.44, available 9.36; nitrogen 0.50; potash 2.37; availability of nitrogen 56; chlorine 2.1.

Remark: Availability of nitrogen too low for materials guaranteed. Chlorine excessive.

6662. Ober's Standard Potash Compound. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 10, reverted 2, insoluble 1, total 13, available 12; potash 5; phosphoric acid from H. G. Florida phosphate; potash from muriate of potash. Found: Phosphoric acid, soluble 10.27, reverted 2.75, insoluble 1.94, total 14.96, available 13.02; potash 4.91; chlorine 0.9.

661. Ober's Dissolved Bone Phosphate and Potash. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 2; phosphoric acid from High Grade Florida phosphate; potash from sulphate of potash. Found: Phosphoric acid, soluble 8.29, reverted 3.63, insoluble 2.02, total 13.94, available 11.92; potash 2.24; chlorine 3.2.

Remarks: Chlorine excessive.

6673. High Grade Acid Phosphate. R. N. Stewart & Son, Agent, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 14.50, reverted 1.50, insoluble 1, total 17, available 16; phosphoric acid from high grade Florida phosphate. Found: Phosphoric acid, soluble 15.97; reverted 2.49, insoluble 1.20, total 19.66, available 18.46.

6674. Ober's Dissolved Bone Phosphate. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 11, reverted 3, insoluble 1, total 15, available 14; phosphoric acid from high grade Florida phosphate. Found: Phosphoric acid soluble 14.14; reverted 2.98, insoluble 1.16, total 18.28, available 17.12.

PIEDMONT—MT. AIRY GUANO COMPANY, BALTIMORE MD.

6571. Piedmont Potato Producer. A. J. Hess, Agent, Mannington, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 7, available 5, nitrogen 2.09, potash 6; phosphoric acid from dissolved bone and phosphate rock; nitrogen 1-3 from bone tankage, 1-3 from nitrate of soda, 1-3 from blood; potash from high grade muriate. Found: Phosphoric acid, soluble 4.85, reverted 1.58, insoluble 0.56, total 6.99; available 6.33; nitrogen 1.45; potash 7.95; availability of nitrogen 81; chlorine 1.3.

Remark: Nitrogen low.

6584. Piedmont 16% Acid Phosphate. Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, insoluble 1; total 15; available 16; phosphoric acid from Florida and Tennesee Phosphate. Found: Phosphoric acid, soluble 13.42, reverted 2.64, insoluble 0.71, total 16.77, available 16.06.

6588. Piedmont Farmers Favorite. A. J. Hess, Agent, Mannington, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 10, available 8; nitrogen 0.82; potash 4; phosphoric acid from acidulated rock and bone tankage; nitrogen 1-2 from blood and 1-2 from bone tankage; potash 1-2 from muriate and 1-2 from kainit. Found: Phosphoric acid, soluble 6.28, reverted 1.55, insoluble 0.75, total 8.58, available 7.83, nitrogen 0.83, potash 4.99; availability of nitrogen 62; chlorine 1.8.

6612. Piedmont Pure Raw Bone Mixture. Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, insoluble 4, total, 12, available 8;nitrogen 1.02; potash 2; phosphoric acid from dissolved bone tankage; nitrogen from bone tankage; potash 1-2 from muriate, 1-2 from kainit. Found: Phosphoric acid, soluble 2.63, reverted 5.87, insoluble 2.83, total 11.33, available 8.50,

nitrogen 1.19, potash 3.94; availability of nitrogen 76; chlorine 3.2.
Remark: Chlorine excessive.

6616. Piedmont Potato Producer. Bishop & Barge, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, insoluble 2, total 7, available 5; nitrogen 2.09; potash 6; phosphoric acid from dissolved bone and phosphate rock; nitrogen 1-3 from bone tankage, 1-3 from nitrate of soda and 1-3 blood; potash from high grade muriate of potash. Found: Phosphoric acid, soluble 3.87, reverted 1.23, insoluble 0.40, total 5.50, available 5.10; nitrogen 2.08; potash 7.90; availability of nitrogen 79; chlorine 0.8.

6667. Piedmont Special Potash Mixture. G. W. Neiswander & Co., Parkersburg, W. Va. Guarantee: Phosphoric acid, insoluble, 1, total 11, available 10; potash 5; phosphoric acid from dissolved phosphate rock; potash 1-2 from muriate of potash, 1-2 from kainit. Found: Phosphoric acid soluble 7.65; reverted 2.47, insoluble 1.03; total 11.15, available 10.12; potash 6.71; chlorine 1.4.

6598. Piedmont Farmers' High Grade Bone and Potash, Bishop & Barbe, Agent, Jane Lew, W. Va. Guarantee: Phosphoric acid, insoluble, 2, total 12, available 10; potash 2; phosphoric acid from high grade Florida rock; potash from kainit. Found: Phosphoric acid, soluble 7.46, reverted 2.95, insoluble 1.28; total 11.69, available 10.41, potash 2.46; chlorine 2.8.

RASIN-MONUMENTAL COMPANY, BALTIMORE, MD.

6483. Rasin's Acid Phosphate. C. W. Myers & Sons, Agent, Terra Alta, W. Va. Guarantee: Phosphoric acid, soluble 12, reverted 2, insoluble 1, total 15, available 14; phosphoric acid from high grade Florida, Tennessee and Charleston phosphate; Found: Phosphoric acid, soluble 12.42; reverted 3.30, insoluble 1.26, total 16.98, available 15.72.

6677. Rasin's Acid Phosphate. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: (As above). Found: Phosphoric acid, soluble 13.10; reverted 3.32; insoluble 0.83; total 17.25; available 16.42.

6513. Rasin's Wheat, Corn & Oats Mixture. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8;

nitrogen 0.41; potash 2; phosphoric acid from high grade Florida, Tennessee and Charleston phosphate; nitrogen 1-5 to 1-4 high grade fish, 1-3 to 1-2 high grade animal tankage, 1-6 to 1-5 blood, 1-6 to 1-5 high grade sulphate of ammonia; potash 1-2 to 2-3 high grade muriate of potash, 1-3 to 1-2 genuine German kainit. Found: Phosphoric acid, soluble 6.65, reverted 2.02, insoluble 1.29, total 9.96, available 8.67, nitrogen 0.54; potash 2.05; availability of nitrogen 75; chlorine 0.8.

Remark: Availability of nitrogen too low for materials guaranteed.

6514. Rasin's Royal Fish, Bone & Potash. Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 1:65; potash 3; phosphoric acid from high grade Florida, Tennessee and Charleston phosphate; nitrogen 1-2 to 3-4 high grade fish, 1-4 to 1-3 high grade animal tankage, 1-5 to 1-3 animal bone; potash 1-2 to 2-3 high grade muriate of potash, 1-3 to 1-2 genuine German kainit. Found: phosphoric acid, soluble 7.37; reverted 2.69, insoluble 1.52; total 11.58, available 10.06; nitrogen 1.65; potash 2.38; availability of nitrogen 86; chlorine 0.4.

Remark: Potash low.

6517. Washington, Alexander & Cooke's Regular Corn Mixture, Washington, Alexander & Cooke, Agent, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10, potash 4; phosphoric acid from high grade Charleston, Florida and Tennessee Phosphate; potash 2-3 from high grade muriate of potash, 1-3 from genuine German kainit. Found: Phosphoric acid, soluble 6.93, reverted 3.55, insoluble 1.03; total, 11.51, available 10.48; potash 3.98; chlorine 1.7.

6565. Rasin's National Crop Compound. W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 0.82; potash 4; phosphoric acid from high grade Florida, Charleston and Tennessee phosphate; nitrogen 1-5 to 1-4 high grade fish, 1-3 to 1-2 high grade tankage, 1-6 to 1-5 blood, 1-6 to 1-5 high grade sulphate of ammonia; potash 1-2 to 2-3 high grade muriate of potash, 1-3 to 1-2 genuine German kainit. Found: Phosphoric acid, soluble

5.88, reverted 1.95; insoluble 1.56, total 9.38, available 7.83; nitrogen 0.93; potash 4.17; availability of nitrogen 79; chlorine .8.

Remark: Availability of nitrogen too low for materials guaranteed.

6592. Monumental Potato Manure. A. P. Russell & Co., Agent, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 4, reverted 2, insoluble 1, total 7, available 6; nitrogen 1.65; potash 7; phosphoric acid from high grade Florida, Charleston & Tennessee Phosphate; nitrogen 1-2 to 3-4 high grade fish, 1-4 to 1-2 high grade animal tankage; potash 1-10 high grade sulphate of potash, 9-10 high grade muriate of potash. Found: Phosphoric acid, soluble 4.26, reverted 1.58, insoluble 1.48, total 8.32, available 6.84; nitrogen 1.72; potash 8.08; availability of nitrogen 91; chlorine 0.2.

6572. Monumental Potato Manure. W. H. Bailey & Sons, Agent, Morgantown, W. Va. Guarantee: (As above) Found: Phosphoric acid, soluble 4.52, reverted 2.09, insoluble 1.30, total 7.91, available 6.61, nitrogen 1.81, potash 7.94, availability of nitrogen 87; chlorine 0.2.

6581. Sea Wall Special. A. P. Russell & Co., Agents, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10. Phosphoric acid from Charleston, S. C., phosphate. Found: Phosphoric acid, soluble 9.26, reverted 2.72, insoluble 1.29, total 13.27, available 11.98.

6589. Raisin's XXX Fertilizer. W. H. Bailey & Son, Agents, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 1.65; potash 5; phosphoric acid from high grade Florida, Tennessee and Charleston phosphate; nitrogen one-fifth to one-fourth high grade fish, one-third to one-half high grade animal tankage, one-sixth to one-fifth blood, one-sixth to one-fifth high grade sulphate of ammonia; potash one-half to two-thirds high grade muriate of potash, one-third to one-half genuine German kainit. Found: Phosphoric acid, soluble 6.57, reverted 2.38, insoluble 1.66, total 10.51, available 8.85, nitrogen 1.74, potash 4.95; availability of nitrogen 90; chlorine 0.2.

6599. Rasin's Special Bone and Potash. A. P. Russell & Co., Agents, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 5;

phosphoric acid from high grade Florida, Charleston and Tennessee phosphate; potash one-half to three-fourths high grade muriate of potash, one-fourth to one-half genuine German kainit. Found: Phosphoric acid, soluble 7.16, reverted 4.67, insoluble 1.91, total 13.74, available 11.83; potash 4.79; chlorine 1.6.

6626. Special Formula for Corn and Buckwheat. A. P. Russell & Co., Agents, Buckhannon, W. Va. Guarantee: Phosphoric acid, soluble 4, reverted 2, insoluble 1, total 7, available 6; potash 3; phosphoric acid from high grade Florida, Tennessee and Charleston phosphate; potash one-half to three-fourths high grade muriate of potash, one-fourth to one-half genuine German kainit. Found: Phosphoric acid, soluble 3.98, reverted 2.46, insoluble 1.12, total 7.56, available 6.44; potash 3.19, chlorine 1.6.

6600. Special Formula for Corn and Buckwheat. W. H. Bailey & Son, Agents, Morgantown, W. Va. Guarantee: (As above.) Found: Phosphoric acid, soluble 4.15; reverted 1.98, insoluble 1.06, total 7.19, available 6.13; potash 2.50; chlorine 1.4.

Remark: Potash low.

6623. Rasin's Wheat Potash Mixture. W. H. Bailey & Son, Agents, Morgantown, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; potash 5; phosphoric acid from high grade Florida, Tennessee and Charleston phosphate; potash one-half to three-fourths high grade muriate of potash, one-fourth to one-half genuine German kainit. Found: Phosphoric acid, soluble 6.38, reverted 3.21, insoluble 1.48, total 11.07, available 9.59; potash 5.04; chlorine 2.4.

6647. Wm. Penn Crop Grower. Miller Supply Co., Agents, Martinsburg, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 1, total 9, available 8; nitrogen 0.82, potash 1; phosphoric acid from high grade Florida, Tennessee and Charleston phosphate; nitrogen one-fifth to one-fourth high grade fish, one-third to one-half high grade tankage, one-sixth to one-fifth blood, one-sixth to one-fifth high grade sulphate of ammonia, potash one-half to two-thirds high grade muriate of potash, one-third to one-half genuine German kainit. Found: Phosphoric acid, soluble 6.53, reverted 2.46, insoluble 1.51, total 10.50, available 8.99, nitrogen 1.03; potash 1.21; availability of nitrogen 85; chlorine 1.1.

6648. Washington, Alexander & Cook's Special Mixture for

Wheat. Washington, Alexander & Cooke, Agents, Charles Town, W. Va. (Not registered this year.) Guarantee: Phosphoric acid, soluble 7, reverted 2, insoluble 1.50, total 10.50, available 9; potash 2; nitrogen 0.82; phosphoric acid from high grade Charleston, Florida and Tennessee phosphate, potash 1-2 to 2-3 from high grade muriate of potash, 1-3 to 1-2 from genuine German kainit; nitrogen 1-5 to 1-4 from high grade fish, 1-3 to 1-2 from high grade tankage, 1-6 to 1-5 from blood, 1-6 to 1-5 from sulphate of ammonia. Found: Phosphoric acid, soluble 6.17, reverted 2.69, insoluble 1.73, total 10.59, available 8.86, nitrogen 1.08; potash 1.99, availability of nitrogen 82. chlorine 2.6.

6649. Washington, Alexander & Cook's Quarter Mixture. Washington, Alexander & Cook, Agents, Charles Town, W. Va. Guarantee: Phosphoric acid, soluble 6, reverted 2, insoluble 4, total 12, available 8; nitrogen 1.33, potash 3; phosphoric acid 500 lbs. from raw animal bone, 500 lbs. from dissolved animal bone, 500 lbs from 14 per cent acid phosphate; nitrogen 500 lbs from raw animal bone, 500 lbs. from dissolved animal bone; potash 500 lbs. genuine German kainit. Found: Phosphoric acid, soluble 3.09, reverted 4.77, insoluble 5.75, total 13.61, available 7.86; nitrogen 1.39; potash 3.45; availability of nitrogen 71; chlorine 3.3.

SOUTHERN FERTILIZING COMPANY, YORK, PA.

6464. Dissolved Phosphate. Guy Means, Agent, Grafton, W. Va. Guarantee: Phosphoric acid soluble 12, reverted 2, insoluble 1, total 15, available 14, phosphoric acid from high grade phosphate rock. Found: Phosphoric acid soluble 12.22, reverted 3.75, insoluble 1.05, total 17.02, available 15.97.

D. A. THOMAS & CO., HAGERSTOWN, MD.

6520. Potash Special. W. M. & J. C. Burns, Agents, Charles Town, W. Va. Guarantee: Phosphoric acid soluble 10, reverted 2, insoluble 1, total 13, available 12, potash 5, phosphoric acid from acid phosphate, potash four-fifths from kainit, one-fifth from muriate of potash. Found: Phosphoric acid soluble 10.09 reverted

2.41, insoluble 0.75, total 13.25, available 12.50, potash 4.95, chlorine 1.8.

6521. Penn Special. W. M. & J. C. Burns, Agents, Charles Town, W. Va. Guarantee: Phosphoric acid soluble 8, reverted 2, insoluble 1, total 11, available 10, potash 4, phosphoric acid from acid phosphate, potash from kainit Found: Phosphoric acid soluble 5.69, reverted 4.78, insoluble 0.75, total 11.12, available 10.37, potash 4.15, chlorine 2.8.

6671. Dissolved Bone Phosphate. W. M. & J. C. Burns, Agents, Charles Town, W. Va. Guarantee: Phosphoric acid soluble 12, reverted 4, insoluble 1, total 17, available 16, phosphoric acid from high grade phosphate rock. Found: Phosphoric acid soluble 13.88, reverted 3.91, insoluble 0.60, total 18.39, available 17.79.

6522. Dissolved Bone Phosphate. W. M. & J. C. Burns, Agents, Charles Town, W. Va. Guarantee: (As above.) Found: Phosphoric acid soluble 15.88, reverted 2.06, insoluble 0.22, total 18.16, available 17.94.

6523. Thomas's Bone and Potash Mixture. W. M. & J. C. Burns, Agents, Charles Town, W. Va. Guarantee: Phosphoric acid soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 1.65, potash 2; phosphoric acid from high grade acid phosphate, nitrogen one-fourth from high grade animal tankage, three-fourths from high grade garbage tankage, potash from kainit. Found: Phosphoric acid soluble 5.61, reverted 2.08, insoluble 0.51, total 8.20, available 7.79, nitrogen 2.06, potash 2.75, availability of nitrogen 93, chlorine 2.6.

6524. Thomas's Wheat and Grass Mixture. W. M. & J. C. Burns, Agents, Charles Town, W. Va. Guarantee Phosphoric acid soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 0.8235, potash 2, phosphoric acid from high grade acid phosphate, nitrogen from garbage tankage, potash from kainit. Found: Phosphoric acid soluble 6.29, reverted 2.47, insoluble 0.40, total 9.16, available 8.76, nitrogen 0.78, potash 2.58, availability of nitrogen 80, chlorine 2.5.

6642. Crown Jewel. W. M. & J. C. Burns, Agents, Charles Town, W. Va. Guarantee: Phosphoric acid soluble 7, reverted 2, insoluble 1, total 10, available 9, nitrogen 0.8235, potash 3, phosphoric acid from high grade acid phosphate, nitrogen from garbage tankage, potash from kainit. Found: Phosphoric acid soluble 7.27, reverted 2.75, insoluble 0.73, total 10.75, available 10.02, nitrogent 0.91, potash 2.74, availability of nitrogen 64, chlorine 2.9.

6675. Dissolved Bone Phosphate. W. N. Lemon & Son, Agents, Shepherdstown, W. Va. Guarantee: Phosphoric acid, soluble 11, reverted 3, insoluble 1, total 15, available 14; phosphoric acid from high grade phosphate rock. Found: Phosphoric acid, soluble 11.76, reverted 4.40, insoluble 0.63, total 16.79, available 16.16.

I. P. THOMAS & SON CO., 1000 DREXEL BUILDING, PHILADELPHIA, PA.

6672. S. C. Phosphate. T. P. Licklider, Agent, Martisburg, W. Va. Guarantee: Phosphoric acid, insoluble 1, total 15, available 14; phosphoric acid from acid phosphate. Found: Phosphoric acid, soluble 11.95, reverted 3.75, insoluble 0.65, total 16.35, available 15.70.

VIRGINIA-CAROLINA CHEMICAL CO., RICHMOND, VA.

6472. V. C. C. Co's. Special Bone and Potash. E. Shoemaker, Agent, Marlinton, W. Va. Guarantee: Phosphoric acid, soluble 8, reverted 2, insoluble 1, total 11, available 10; potash 5; phosphoric acid from high grade Florida, Tennessee and Charleston phosphate, potash one-half to three-fourths high grade muriate of potash, one-fourth to one-half genuine German kainit. Found: Phosphoric acid, soluble 8.18, reverted 2.68, insoluble 1.03, total 11.89, available 10.86; potash 4.38; chlorine 1.0.

Remark:—Potash low.

6473. V. C. C. Co's. Corn and Buckwheat Special. E. Shoemaker, Agent, Marlinton, W. Va. Guarantee: Phosphoric acid, soluble 4, reverted 2, insoluble 1, total 7, available 6; potash 3, phosphoric acid from high grade Florida, Tennessee and Charleston phosphate; potash one-half to three-fourths from high grade muriate of potash, one-fourth to one-half from genuine German kainit. Found: Phosphoric acid, soluble 5.29, reverted 1.63, insoluble 0.77, total 7.69, available 6.92; potash 2.99; chlorine 1.5.

6475. Floats. Lewisburg Supply Company, Agents, Lewisburg, W. Va. Found: Phosphoric acid, total 29.82.

6494. V. C. C. Co's. Special Potash Mixture. A. E. Hanna, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 3, insoluble 1, total 11, available 10; potash 4; phosphoric acid from high grade S. C. phosphate rock; potash from sulphate of potash. Found: Phosphoric acid, soluble 7.17, reverted 2.74, insoluble 0.70, total 10.61, available 9.91; potash 3.07; chlorine 1.1.

Remark:—Potash low; chlorine excessive.

6495. V. C. C. Co's. Pure Raw Bone. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 1, reverted 7, insoluble 14.50, total 22.50, available 8; nitrogen 3.70; phosphoric acid from animal bone, nitrogen from animal bone. Found: Phosphoric acid, total 22.68, nitrogen 3.98, availability of nitrogen 55.

6496. V. C. C. Co's. National Ammoniated Guano. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 0.82, potash 4, phosphoric acid from high grade Florida, Tennessee and Charleston phosphate, nitrogen one-fifth to one-fourth high grade fish, one-third to one-half high grade animal tankage, one-sixth to one-fifth blood, one-sixth to one-fifth high grade sulphate of ammonia, potash one-half to two-thirds high grade muriate of potash, one-third to one-half genuine German kainit. Found: Phosphoric acid soluble 6.49, reverted 1.33, insoluble 0.47, total 8.29, available 7.82, nitrogen 0.92, potash 4.50, availability of nitrogen 70, chlorine 1.2.

Remark: Availability of nitrogen too low for materials guaranteed.

6497. V. C. C. Co's. 16 per cent Acid Phosphate. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid soluble 13, reverted 3, insoluble 1, total 17, available 16, phosphosic acid from high grade S. C. phosphate rock. Found: Phosphoric acid soluble 12.30, reverted 3.89, insoluble 0.42, total 16.61, available 16.19.

6498. V. C. C. Co's. 14 per cent Acid Phosphate. E. A. Hanna, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid soluble 12, reverted 2, insoluble 1, total 15, available 14, phosphoric acid from high grade Florida, Tennessee and Charleston phosphate. Found: Phosphoric acid soluble 10.56, reverted 3.42, insoluble 0.43, total 14.41, available 13.98.

6646. V. C. Co's. Fish Bone and Potash. G. T. Hodges, Agent, Shepherdstown, W. Va. Guarantee: Phosphoric acid soluble 6, reverted 2, insoluble 1, total 9, available 8, nitrogen 1.65, potash 3, phosphoric acid from high grade Florida, Tennessee and Charleston phosphate, nitrogen one-half to three-fourths high grade fish, one-fourth to one-third high grade animal tankage, one-fifth to one-third animal bone, potash one-half to two thirds high grade muriate of potash, one-third to one-half genuine German kainit. Found: Phosphoric acid soluble 5.66, reverted 2.84, insoluble 2.10, total 10.60, available 8.50, nitrogen 1.62, potash 3.61, availability of nitrogen 84, chlorine 1.1.

6499. Allison & Addison's B. P. Potash Mixture. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 3, insoluble 1, total 11, available 10, potash 2, phosphoric acid from high grade S. C. phosphate rock, potash from sulphate of potash. Found: Phosphoric acid soluble 6.35, reverted 2.99, insoluble 0.79, total 10.13, available 9.34, potash 3.07, chlorine 1.8.

Remark: Phosphoric acid law.

6501. Allison & Addison's Little Giant Grain & Grass Grower. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid soluble 6, reverted 2, insoluble 2, total 10, available 8, nitrogen 0.82, potash 2, phosphoric acid from high grade S. C. phosphate rock, nitrogen one-fourth H. G. Dry Fish, one-fourth H. G. animal tankage, one-half sulphate of ammonia, potash from sulphate of potash. Found: Phosphoric acid soluble 7.48, reverted 3.34, insoluble 0.69, total 11.51, available 10.82, nitrogen 0.80, potash 1.93, availability of nitrogen 82, chlorine 0.2.

Remark: Availability of nitrogen too low for materials guaranteed.

6502. S. W. Travers & Co's. Dissolved Bone Phosphate. J. M. Miller, Agent, Ronceverte, W. Va. Guarantee: Phosphoric acid soluble 11, reverted 3, insoluble 1, total 15, available 14, phosphoric acid from H. G. S. C. phosphate rock. Found: Phosphoric acid soluble 11.35, reverted 2.95, insoluble 0.33, total 14.63, available 14.30.

6500. S. W. Travers & Co's. Champion Corn, Wheat and Grass Grower. A. E. Hanna, Agent, Spring Creek, W. Va. Guarantee: Phosphoric acid soluble 6, reverted 2, insoluble 2, total 10, available 8, nitrogen 0.82, potash 1, phosphoric acid from H. G. S. C. phosphate rock, nitrogen one-fourth from H. G. Dry Fish, one fourth from H. G. animal tankage, one-half sulphate of ammonia, potash from suplhate of potash. Found: Phosphoric acid soluble 6.03, reverted 2.34, insoluble 1.01, total 9.38, available 8.37, nitrogen 0.86, potash 1.07, availability of nitrogen 74, chlorine 0.2.

Remark: Availability of nitrogen too low for materials guaranteed.

6474. Southern Chemical Co's. Sun Brand Guano. E. Shoemaker, Agent, Marlinton, W. Va. Guarantee: Phosphoric acid sa l uble 6, reverted 2, insoluble 2, total 10, available 8, nitrogen 2.06, potash 5, phosphoric acid from H. G. S. C. phosphate rock, nitrogen one-fourth from H. G. dry fish, one fourth H. G. animal tankage, one-half sulphate of ammonia, potash from sulphate of potash. Found: Phosphoric acid soluble 6.29, reverted 1.82 insoluble 1.29, total 9.40, available 8.11, nitrogen 1.99, potash 5.36, availability of nitrogen 91, chlorine 0.6.

6668. Cooper's Special Wheat Grower. H. C. Cooper, Agent, Romney, W. Va. Guarantee: Phosphoric acid soluble 4, reverted 2, insoluble 1, total 7, available 6, potash 3, phosphoric acid from high grade Florida, Tennessee and Charleston phosphate, potash one-half to three-fourths high grade muriate of potash, one-fourth to one-half genuine German kainit. Found: Phosphoric acid soluble 1.59, reverted 4.63, insoluble 1.39, total 7.61, available 6.22, potash 3.36, chlorine 2.4.

ROBERT A. WOOLDRIDGE CO., BALTIMORE, MD.

6566. Wooldridge's Triumph Brand Phosphate. R. L. & H. C. Rogers, Agents, Rowlesburg, W. Va. Guarantee: Phosphoric acid soluble 6, reverted 2, insoluble 1.50, available 8, nitrogen 1.23, potash 4, phosphoric acid three-fourths from dissolved phosphate rock, one-fourth from bone and tankage, nitrogen two-fifths from fish, two-fifths from bone tankage, one-fifth bone, potash one-half from muriate of potash, one-half from manure salts. Found: phosphoric acid soluble 6.62, reverted 1.79, insoluble 1.26, total 9.67, available 8.41, nitrogen 1.38, potash 4.26, availability of nitrogen 81, chlorine 1.9.

6569. Wooldridge's Special Potato and Tobacco Fertilizer. Stansberry & Summers, Agents, Little Falls, W. Va. Guarantee: Phosphoric acid, soluble 7, reverted 2, insoluble 1.50, available 9, nitrogen 1.65, potash 5, phosphoric acid three-fourths from dissolved phosphate rock, one-fourth from bone tankage, nitrogen three-fifths from bone tankage, two-fifths fish, potash one-half from muriate of potash, one-half from high grade manure salts. Found: Phosphoric acid soluble 7.33, reverted 2.85, insoluble 1.95, total 12.13, available 10.18, nitrogen 1.77, potash 5.44, availability of nitrogen 87, chlorine, 1.4.

6577. Wooldridge's Florida Acid Phosphate. R. L. & H. C. Rogers, Agents, Rowlesburg, W. Va. Guarantee: Phosphoric acid soluble 12, reverted 2, insoluble 1.50, available 14, phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid soluble 12.39, reverted 3.56, insoluble 0.63, total 16.58, available 15.95.

6595. Wooldridge's Liberty Bell Potash Mixture. Stansberry & Summers, Agents, Little Falls, W. Va. Guarantee: Phosphoric acid soluble 10, reverted 2, insoluble 1, available 12, potash 3, phosphoric acid from dissolved phosphate rock, potash one-half from manure salts, one-half from muriate of potash. Found: Phosphoric acid soluble 9.20, reverted 3.56, insoluble 0.89, total 13.65, available 12.76, potash 3.25, chlorine 3.3.

Remark: Chlorine excessive.

6596. Wooldridge's No. 1 Phosphate and Potash. Stansberry & Summers, Agents, Little Falls, W. Va. Guarantee: Phosphoric acid soluble 4, reverted 2, insoluble 1, available 6, potash 3, phosphoric acid from dissolved phosphate rock, potash one-half from muriate of potash, one-half from manure salts. Found: Phosphoric acid soluble 3.01, reverted, 3.47, insoluble 1.05, total 7.53, available 6.48, potash 3.18, chlorine 5.6.

Remark: Chlorine excessive.

6597. Wooldridge's Old Sledge Phosphate. Stansberry & Summers, Agents, Little Falls, W. Va. Guarantee: Phosphoric acid soluble 10, reverted 2, insoluble 1, available 12, potash 5, phosphoric acid from dissolved phosphate rock, potash two-fifths from muriate of potash, three-fifths from manure salts. Found: Phosphoric acid soluble 9.49, reverted 3.64, insoluble 0.56, total 13.69, available 13.13, potash 5.65, chlorine 2.0.

6604. Wooldridge's German Potash Mixture. R. L. & H. C. Rogers, Agents, Rowlesburg, W. Va. Guarantee: Phosphoric acid soluble 8, reverted 2, insoluble 1, available 10, potash 2, phosphoric acid from dissolved phosphate rock, potash from kainit. Found: Phosphoric acid soluble 7.37, reverted 3.34, insoluble 0.80, total 11.51, available 10.71, potash 2.16, chlorine 6.2.

Remark: Chlorine excessive.

6585. Wooldridge's High Grade Acid Phosphate 16 per cent. M. Bolton, Agent, Belington, W. Va. Guarantee: Phosphoric acid soluble 13, reverted 3, insoluble 1.50, available 16 phosphoric acid from dissolved phosphate rock. Found: Phosphoric acid soluble 15.28, reverted 3.31, insoluble 0.17, total 18.76, available 18.59.

Robt. A. Wooldridge trading as The Wooldridge Fertilizer Company, Baltimore, Md.

6567. High Grade Potato and Tomato Grower. M. C. Cochran, Agent, Worthington, W. Va. Guarantee: Phosphoric acid soluble 6, reverted 3, insoluble 0.50, total 9.50, available 9, nitrogen 1:65, potash 5, phosphoric acid two-thirds from acid phosphate, one-third from tankage, nitrogen two-thirds from bone tankage, one-third from sulphate of ammonia, potash one-half from muriate of potash, one-half from manure salts. Found: Phosphoric acid soluble 6.93, reverted 2.72, insoluble 1.05, total 10.70, available 9.65, nitrogen 1.83, potash 5.98, availability of nitrogen 90, chlorine 1.5.

6568. Tiger Bone Stock Phosphate. M. C. Cochran, Agent, Worthington, W. Va. Guarantee: Phosphoric acid soluble 5, reverted 3, insoluble 0.50, total 8.50, available 8, nitrogen 1.03, potash 4.50, phosphoric acid three-twentieths from bone and slaughter house tankage, one-twentieth from garbage tankage, four fifths from acid phosphate, nitrogen one-third from sulphate of ammonia, one-third from bone and slaughter house tankage, one-third from garbage tankage, potash one-half from muriate of potash, one-half from manure salts. Found: Phosphoric acid soluble 4.72, reverted 3.65, insoluble 1.29, total 9.66, available 8.37, nitrogen 1.23, potash 4.87, availability of nitrogen 82, chlorine 2.3.

Remark: Chlorine excessive.

6601. Virginia Bell. M. C. Cochran, Agent, Worthington, W. Va. Guarantee: Phosphoric acid soluble 9, reverted 3, insoluble 1, total 13, available 12, potash 3, phosphoric acid from acid phosphate, potash from manure salts. Found: Phosphoric acid soluble 5.51, reverted 8.30, insoluble 0.55, total 14.36, available 13.81, potash 3.54, chlorine 3.6.

Remark: Chlorine excessive.

6579. Curacao Guano. W. H. Gwyn, Agent, Little Falls, W. Va. Guarantee: Phosphoric acid reverted 8.50, insoluble 11.50, total 20, available 8.50, phosphoric acid from natural guano bird deposit. Found: Phosphoric acid soluble trace, reverted 19.38, insoluble 7.88, total 27.26, available 19.38.

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UNIV. OF MICHIGAN,
MAY 15 1912

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 133 APRIL, 1911

Suggestions for Spraying

By permission of The Deming Co., Salem, Ohio

W. E. RUMSEY, N. J. GIDDINGS AND A. L. DACY.

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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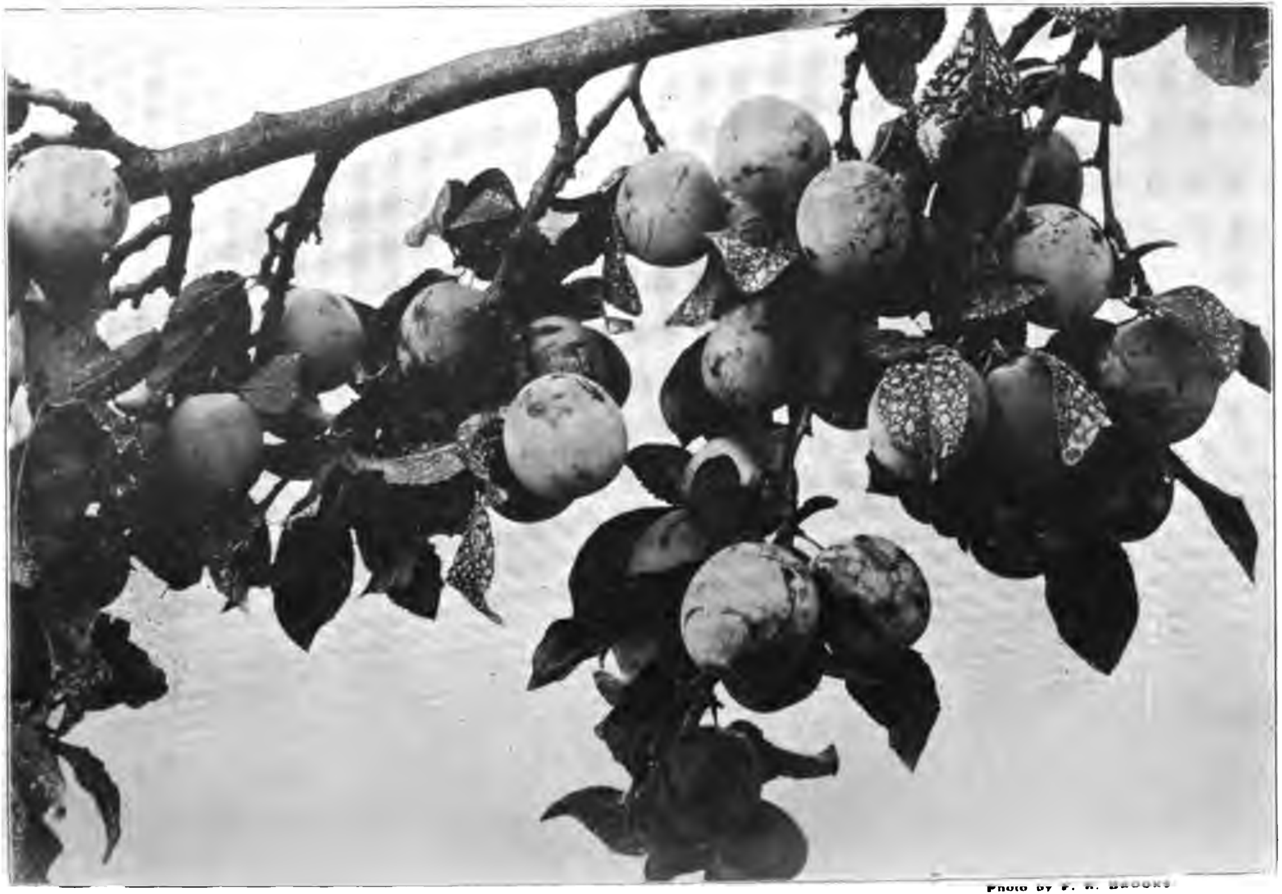

Photo by F. E. BROOKS

Bradshaw plums saved from brown rot and curculio by proper spraying.

Suggestions for Spraying

W. E. RUMSEY, N. J. GIDDINGS AND A. L. DACY

There can no longer be any reasonable doubt as to the value of spraying to prevent or control the injuries to fruits and vegetables, due to the work of fungous diseases and insect pests. It is rapidly taking its place as an essential practice in good farm and orchard management.

There are several problems which confront the man who wishes to begin the practice of spraying that seem difficult and perplexing. This Station is constantly in receipt of inquiries which may be grouped under the questions "How, when and with what shall I spray my crops?" and "where can I obtain the necessary apparatus and material?"

This bulletin has been prepared for the purpose of answering these questions as definitely and as clearly as possible and by so doing help to extend and make more effective the use of the spray pump. It presents nothing original, but seeks to include what scientific investigators and practical orchardists have found to be, up to the present time, the best methods of fighting plant diseases and injurious insects.

Some study of the following pages and the application of what one learns therein will clear up the confusing details and make spraying one of the most profitable, if not the most pleasant of farm operations. "Experience is the best teacher" and "practice makes perfect."

There are a few general statements regarding the practice of spraying to which the beginner's attention is called. To be successful, spraying must be done,

1st. *Intelligently*. Strive to know what you are spraying for. That is "What is the disease and what is the insect you are trying to destroy?" It is not necessary that you should know their life histories, but you should become familiar with the appearance and the common name of our common insect and fungus foes, and the remedy for each.

2nd. *At the proper time*. Spraying is largely preventive.

The spray, if it is to be most effective, must be placed upon the plant before the spore germinates or the insect begins to feed. Learn the proper time for each application.

3rd. *Thoroughly.* All parts of the plant must be covered with the spray solution so that no spore or insect shall escape to reproduce its kind.

EQUIPMENT NEEDED FOR SPRAYING

This will vary, of course, with the kind and amount of spraying to be done, but the following list is suggestive. Spray pump spray barrel or tank, hose, extension rods, nozzles, strainer, gallon measure, small pair of scales, several pails and some 50 gallon barrels if stock solutions of Bordeaux are used. A monkey wrench, alligator wrench, screw driver and other accessories are often needed.

A question very frequently asked is: "What kind of a pump shall I buy?" This can be answered in a general way only, as there are so many varying factors which influence the choice. The usual desire of the beginner is to get as cheap an outfit as possible, and naturally the dealer seeks to fill the demand, with the result that the buyer is often disappointed and discouraged because of his poor results. It is economy to buy the best pump obtainable consistent with the amount of spraying to be done. The various classes of pumps will be described briefly. All working parts of the pump should be of brass.

Bucket pumps, knapsack pumps, small compressed air sprayers. Sutable only for a small area of vegetables or small fruits of a few young trees. The latter class is the most desirable of the three.

Small capacity barrel pumps. Suitable for small home orchards, but slow in operation.

Medium capacity barrel pumps. With a little more power, increased effectiveness and a wider range of usefulness.

Large capacity barrel pumps. The best all around spray outfit except for extensive orchards. Will answer the purpose in such while young and are very desirable to have in large orchards in addition to a power outfit. Can be used in 50 gallon barrel or 100 gallon tank. Can be equipped with one or two leads of hose. For steep land should be mounted on the side of the barrel. Will handle orchards up to 500 trees 20 years of age.

Large capacity hand pumps. Horizontal lever type. These are mounted outside of the barrel or on top of tank and connected to them by a suction hose. Intermediate in capacity between the barrel pump and the power outfit.

Gasolene power outfits. Desirable for orchards of 1,000 trees or over. A great variety on the market, varying from 1½ to 3½ horse power. Ask manufacturers for the names of growers nearest you who are using their machine and get their opinions before ordering.

Traction power sprayers. This class of power outfits are not adapted for general orchard spraying, as a rule, but are designed more particularly for spraying vineyards, potatoes and other field crops and for destroying weeds. They obtain their power from the wheels by means of cams, eccentrics, chains or gears.

Compressed air sprayers. For extensive orchards this type of a spraying outfit offers many advantages. The part of the outfit used in the field consists of two steel tanks (similar to the hot water tanks used in houses) of whatever capacity desired, from 50 to 200 gallons, mounted on a wagon body. One of the tanks holds the spray liquid and the other the air. The air in the latter is compressed by means of a compressor, operated by a gasolene engine located at the central mixing station. This is done while the spray tank is being filled. When ready to spray the operator turns a valve which connects the air tank with that containing the liquid and allows the material to be forced out. The first cost of such an outfit is somewhat greater than that of a gasolene outfit having an equivalent daily capacity. They are lighter than the latter, however, which is a very important factor in spraying hilly orchards. The cost of the field outfit is comparatively small. By having duplicate sets of the tanks, one set can be filling while the other is being emptied, the simple changing of the hose connections from one to the other allowing the operators to continue with their spraying.

Spray hose. A very common mistake is to get too little hose. Each lead should be at least 20 ft. long—25 to 30 ft. is better.

Extension rods. These may be of galvanized iron pipe which may be bought of the local plumber or gas fitter at about 5c a foot, or they may be bought of the spray pump dealer. Bamboo extension rods from 8 to 12 feet long (lined with brass or aluminum pipe,) while expensive, are much lighter and easier to handle, permitting the operator to do better work with less fatigue. All extension rods should be provided with a shut off cock between the end of the hose and the pipe. This gives the operator instant control over the spray and prevents waste of material.

Nozzles. Each manufacturer has a variety of styles. The three common types in use are the Vermorel, the Bordeaux and the large disc type, or modification of these.

The Vermorel throws a fine mist like spray. Suitable for a small capacity pump and small orchards. Too slow for more extensive work. Clogs easily and projection catches in branches.

The Bordeaux nozzel can be regulated so as to throw a solid stream or a narrow to wide fan-shaped spray. Useful in spraying tall trees and in forcing the spray into the calyx cups in coddling moth spray. The projection of the regulating device bothers sometimes by catching in branches.

The large disc type such as the Friend, Mistry Jr., Simplex, Vapo, etc., is the most desirable for general spraying where 100 pounds or more pressure can be maintained. They are light, do not clog easily, offer no obstruction to the branches and reduce the time expense in spraying.

A Strainer may be made of number 50 brass wire, 30 meshes to the inch, or of several thicknesses of cheese cloth. It will save much time in preventing clogging of the nozzles if all material is strained before placing in the spray tank.

Accessories. Among the additional items of equipment that will be found useful may be mentioned rubber discs to attach to spray rods to protect the operators from leaky nozzles; Sherman hose clamps and hose couplings; reducers for connecting one-half inch hose to quarter inch pipe; pressure guage; a discharge "Y" to fit a pump for either one or two leads of hose; a "Y" enabling the use of two nozzles to a lead of hose, a supply of rubber washers for hose couplings; and an angle attachment between nozzles and end of spray rod enabling operator to direct the spray directly against the tree.

Remedies for the More Common Diseases and Insects.

APPLE

Disease or Insect.	Remedy	First Treatment	Other Treatments	Character of Trouble.
Scab.	Lime-sulphur or Bordeaux mixture	Just as leaves are unfolding	Soon after blossoms fall	Olive-gray spots on foliage and fruit
Bitter rot.	Bordeaux Mixture. Prune out cankers	About two months after petals fall	2 or 3 weeks later and repeat if necessary	Brown sunken spots on fruit.
Leaf spot	Lime-sulphur or Bordeaux Mixture	Soon after blossoms fall	Two or three weeks later and repeat if necessary	Brown spots on leaves
Orange or Cedar rust (see note)	Lime-sulphur or Bordeaux Mix.	When cedar apples begin to swell on cedars.		Small orange spots on leaves and large ones on fruit.
Twig blight	Prune off diseased twigs well back and apply corrosive sublimate to wounds	Whenever noticed		Brown leaves clinging to twigs and shrunken bark.
Canker	Prune out where possible. Cut out and paint over	At any time when pruning		There are several forms of canker, all showing some dead bark and ruptures in it.
Hairy root and Crown gall	Don't accept or set out affected trees			Rough enlargements at or below crown and frequently masses of fine hairy roots

(NOTE)—Spraying for cedar rust has given variable results at different times and places, but we believe it may be controlled by careful spraying at the proper time.

Remedies for the More Common Diseases and Insects.

APPLE

Disease or Insect	Remedy	First Treatment	Other Treatments	Character of Trouble.
Sooty blotch or fly speck	Lime-sulphur or Bordeaux Mixture.	Six weeks to two months after petals fall	2 or 3 weeks later if necessary.	Dark specks and patches on fruit.
Codling moth	Arsenate of lead	Just after petals have fallen	About ten weeks later	Wormy apples.
Canker worm	Arsenate of lead. Tree tangle foot.	Band tree trunks when leaves are unfolding	Spray when larvae appear	Foliage eaten.
Curculio	Arsenate of lead	Just after bloom drops		Knotty fruit.
Borers	Cut out. Use knife and wire	Spring	Fall	Borings at base of tree.
San Jose scale	Lime-sulphur or Soluble oil	When trees are dormant		Bark ashen gray. Limbs die back.
Oyster shell scale	Lime - sulphur soluble oil and Kerosene emulsion	When trees are dormant	When eggs hatch in spring with kerosene emulsion	Small oyster-shell-like objects on the bark.
Scurfy scale	do	do	do	Small whitish pear-shaped objects on the bark.
Woolly aphis	Kerosene emulsion. Tobacco decoction.	Spring	Summer	White woolly patches on trunk or branches. Knotty excrescences on roots.
Green aphis	do	Unfolding of the leaves		Curled conditions of foliage during summer.

Remedies for the More Common Diseases and Insects.

PEAR

Disease or Insect	Remedy	First Treatment	Other Treatments	Character of Trouble.
Scab	Bordeaux or lime-sulphur	Just as leaves open	Just after blossoms fall	Dark olive spots on fruit and leaves. Fruit often cracked.
Fire blight	Frequent pruning and spraying	Prune any time diseased twigs are noticed, cutting well back and disinfecting cut surface with 1-1000 corrosive sublimate		Dry brown leaves clinging to twigs and shrunken bark.
Leaf blight	Bordeaux Mixture or lime-sulphur.	Same treatment as for scab.		
Blistermite	Lime-sulphur	When buds are swelling with strong spray	Just after bloom falls, weak spray	Spotted foliage.
Codling moth	See under apple			
Curculio	See under apple			
San Jose scale	See under apple			

Remedies for the more Common Diseases and Insects.

PEACH

Disease or Insect	Remedy	First Treatment	Other Treatments	Character of Trouble.
Brown rot	Self boiled lime sulphur. Destroy rotted fruit	Four weeks after petals fall	About one month later and one month before fruit ripens	Rotted fruit covered with light brown pustules.
Scab	Self boiled lime sulphur	do	do	Olive colored spots on fruit.
Curl	Strong Bordeaux mixture or lime-sulphur	One to four weeks before buds start		Leaves curled and distorted.
Yellows	Dig out and destroy.	As soon as noticed		Early opening of buds, premature ripening and red spotting of fruit.
Mildew	Self boiled lime sulphur.	As soon as noticed		Whitish growth on leaves and twigs
Curculio	Arsenate of lead	When flower husks have dried		Knotty wormy fruit.
San Jose scale	See under apple			
Borers	Cut out, use knife and wire	Spring	Fall	Borings at base of tree.

Remedies for the more Common Diseases and Insects.

PLUM

Disease or Insect.	Remedy	First Treatment	Other Treatments	Character of Trouble.
Brown rot	Self boiled lime sulphur. Destroy rotted fruit	Three or four weeks after petals fall	About one month later	Rotted fruit covered with light brown pustules.
Scab	See under peach			
Black knot	Thorough pruning, Bordeaux mixture, lime sulphur.	In early spring before buds start	About one month later	Large black warty growths on branches
Curculio	Arsenate of lead. Jarring on sheets	Spray after bloom falls; now begin jarring each morning, continue 4 weeks.		Stung fruit.
San Jose scale	See under apple			

Remedies for the More Common Diseases and Insects.

CHERRY

Disease or Insect	Remedy	First Treatment	Other Treatments	Character of Trouble.
Brown rot	See under plum		Omit second spraying	
Black knot	See under plum			
Powdery mildew	Self boiled lime sulphur or Bordeaux Mixture	After leaves have expanded	3 or 4 weeks later	Whitish growth on leaves and young twigs.
Leaf spot	Self boiled lime sulphur or Bordeaux mixture	When leaves are expanding	3 or 4 weeks later	Reddish spots on leaves which often drop out.
Curculio	See under apple			Wormy fruit.
Rose Chafer	Arsenate of lead.	Soon after blossoms fall		Fruit eaten.
San Jose scale	See under apple			

Remedies for the More Common Diseases and Insects.

GRAPE

Disease or Insect.	Remedy	First Treatment	Other Treatments	Character of Trouble.
Black rot	Bordeaux mixture. Destroy diseased fruit	When shoots are 8-12 inches long.	Repeat every 16-18 days till 5 applications have been made.	Fruit turns black and drops off or shrivels and becomes covered with black pustules. Also brown spots on leaves and stems
Downy mildew	do			White downy spots on under side of leaf. Fruit rots, covered with white growth.
Powdery mildew	Bordeaux mixture or sulphur powder	When shoots are 8-12 inches long	After blossoming and repeat if necessary.	Grayish white powdery spots on leaves and stems; hard spots on fruit.
Grape-vine flea beetle	Arsenate of lead	Before flowers open. Strong mixture.	When grapes are set	Holes eaten in leaves
Grape curculio	Arsenate of lead	Soon after grapes set	2 or 3 weeks later	Wormy fruit.
Rose Chafer	Arsenate of lead and jarring into inverted umbrella catcher	Whenever they occur		Fruit devoured.

Remedies for the more Common Diseases and Insects.

POTATO

Disease or Insect.	Remedy	First Treatment	Other Treatments	Character of Trouble.
Early blight	Bordeaux mixture	When plants are 6-8 inches high	Every two or three weeks.	Brown spots on leaves showing concentric rings.
Scab	Formalin or corrosive sublimate	Just before planting		Rough dark areas in tubers
Tip burn	Bordeaux and thorough cultivation	Same as early blight	Same as early blight	Leaves die at tip and roll up.
Colorado potato beetle	Arsenate of lead or Paris green.	Whenever beetles appear.	When necessary	Tops eaten.
Flea beetle	Arsenate of lead and Bordeaux	do	do	Small holes in leaves.

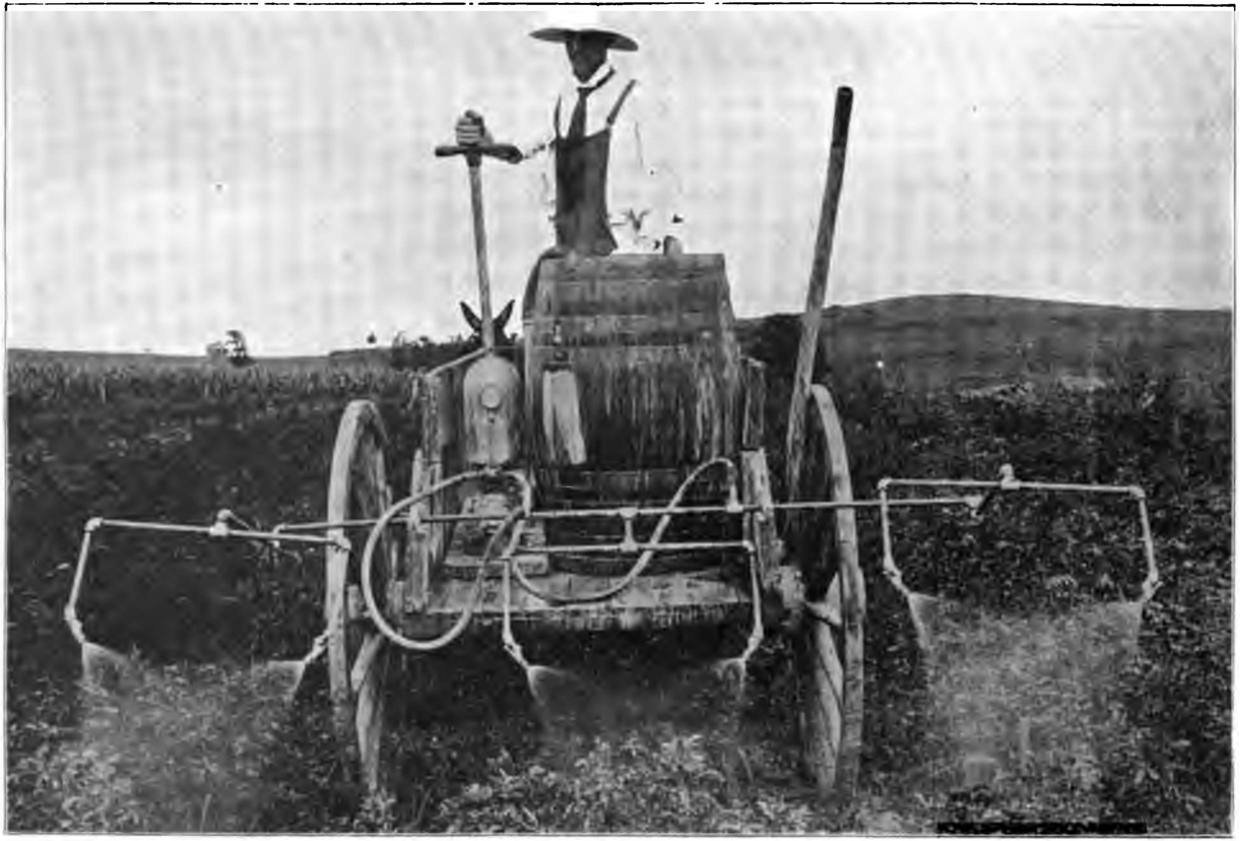

Photo by W. E. RUMSEY

Horizontal lever type of hand pump with home-made potato spraying attachment. Two nozzles to each row.

SPRAY MATERIALS AND FORMULAE

In general orchard spraying the lime-sulphur solutions are taking the place of Bordeaux mixture to a very great extent. The lime sulphur is less apt to burn the foliage and cause russeting of the fruit than Bordeaux, and its use serves to prevent or keep down the San Jose scale. On the other hand, the lime sulphur solutions are not so effective in controlling all orchard diseases, and it too may sometimes cause burning of the foliage. For a poison, Paris green is fast losing favor, as arsenate of lead is more satisfactory in many ways. The chief points in favor of lead arsenate being that it does not burn the foliage, stays in suspension better and is not easily washed off by showers.

Caution: As most spray materials are either poisonous or have strong caustic properties they should be properly labelled and kept out of reach of children and stock.

FUNGICIDES

FORMULA NO 1.—BORDEAUX MIXTURE.

Copper sulphate (Blue stone or blue vitriol)	3 pounds.
Stone lime (unslaked	3 or 5 ”
Water	50 gallons

Use only lump lime as freshly burned as possible. Air slaked lime should not be used. The copper sulphate will corrode iron or tin. Dissolve in a wooden or stone vessel. For making a barrel (or less) of the material, dissolve the copper sulphate in a pail of hot water, pour into the spray tank and dilute to about 40 gallons. Slake the lime by the addition of the required amount of water and when slaked dilute to about five gallons of water. Pour the milk of lime thus made into the copper sulphate solution in the barrel, passing it through a strainer of brass or cheese cloth. Stir while adding the lime and add water to make 50 gallons of spray material.

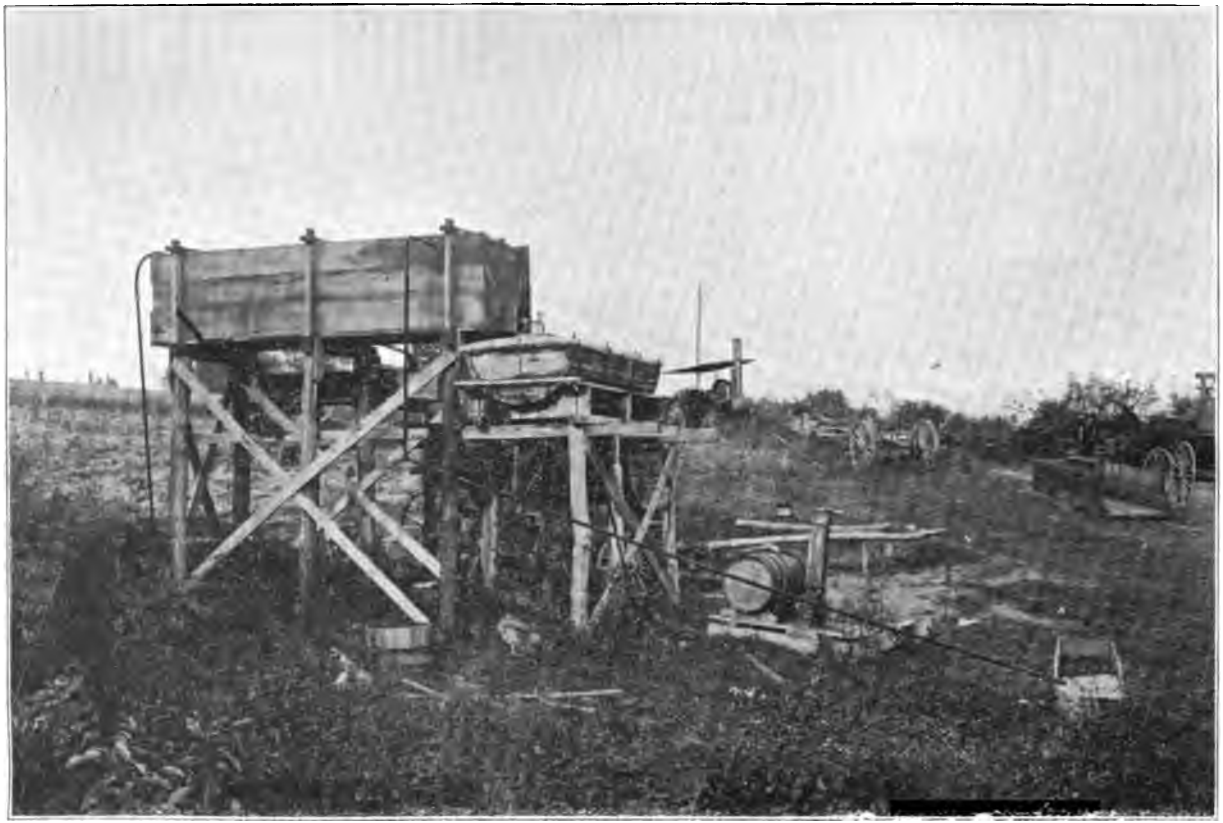

Photo by W. E. Rumsey

A good water supply for spraying. The large tank is filled by gravity from a spring. Water from the main tank is conducted into smaller mixing tanks and the spray tank is filled from these by gravity.

If much spraying is to be done with Bordeaux it is desirable to have a mixing plant. This consists of a platform of such height that its bottom shall be a little above the opening into the spray tank. On the platform may be placed two 50 gallon barrels to hold stock solutions, one of copper sulphate and one of lime. The former is made by suspending 50 pounds of copper sulphate in a burlap sack in the top of barrel filled with water. This may be done at night and it will be all dissolved in the morning. The latter is made by slaking 50 pounds of lime in the barrel and when slaking is completed filling the barrel with water. One gallon of the contents of each barrel, when well stirred will contain one pound of the material in the formula. The platform also supports two other (dilution) receptacles whose added volume equals the capacity of the spray tank. To fill the spray tank the required number of gallons is taken from the copper sulphate stock solution and placed in one of the dilution barrels and the required number of gallons is taken from the lime stock solution and placed in the other dilution barrel. Each is then diluted with the proper amount of water and the two liquids are allowed to run together by gravity, passing through the strainer into the spray tank.

FORMULA NO. 2—STRONG BORDEAUX MIXTURE

Copper sulphate	5 pounds
Stone lime (unslaked	5 "
Water	50 gallons

Prepared same as formula number one. This mixture is for potato, grape and peach leaf curl.

FORMULA NO. 3—SELF BOILED LIME SULPHUR MIXTURE

Fresh Stone Lime	8 pounds
Sulphur, flour or flowers	8 "
Water	50 gallons

The lime should be placed in a vessel and enough water poured on to nearly cover it. Run the sulphur through a sieve to break up the lumps, and preferably mix into a paste with a little water, then add it to the sulphur when the latter is slaking vigorously. Stir occasionally. Keep the vessel covered with gunny sacking, or something of the sort to retain the heat. Add water occasionally to keep the mass in a pastey condition. Stop the boiling as soon as the lime is slaked by adding water to make the 50 gallons, if the material is to be used on peach. When it is to be used on apple let the mass cook twenty minutes after the slaking is completed before adding water to make the 50 gallons.

Formula No. 4—Lime-Sulphur Mixture for Dormant Trees

Fresh lime (unslaked	20 pounds
Sulphur	15 "
Water	50 gallons

For the amount mentioned, slake lime and sulphur together in a large iron kettle; dilute to 15 gallons, and boil for an hour. The liquid should then have changed to a reddish-amber color, and will be ready for use. Dilute to 50 gallons with water, and apply while hot. If more than a few trees are to be sprayed, the most satisfactory method of cooking is to use a jet of live steam and cook in barrels or a tank.

Formula No. 5—Commercial Concentrated Lime-Sulphur Mixture

Concentrated material	1 gallon
Water	9 or 10 gallons

This is the strength recommended for use in spraying dormant trees. For a summer spray use 1½ gallons of the material to 50 gallons of water.

Formula No. 6—Home-made Concentrated Lime-Sulphur Solution.

Fresh Stone Lime	40 pounds
Sulphur, flour or flowers	80 "
Water	50 gallons

Place about ten gallons of water in the cooking vessel. Heat the water and add the lime in small quantities at a time. Mix the sulphur into a paste and add it to the lime as the latter begins to slake. When the slaking is completed add the required amount of water and boil vigorously for one hour. If the mixture is made in a kettle sufficient additional water should be added to make up for the amount lost in boiling, say ten gallons. If cooked by steam the additional water is usually not necessary. Unless one has large kettles or vessels in which to make the mixture it is better to make up a half batch at a time. This material can be kept some time by storing it in air tight vessels.

For use against the San Jose scale the density of the diluted solution should be about 4.5 degrees Beaume; for summer spray on apple or pear about 1 degree Beaume.

Hydrometers of the Beaume type can be purchased from the Bausch and Lomb Optical Co., Rochester, N. Y., for about $1.00.

This instrument consists of a weighted, hollow glass bulb or cylinder with a graduated neck. When immersed in a liquid it sinks far enough to displace a bulk of liquid equal to its own weight, consequently it sinks further in a light than in a heavy solution.

These varying depths are read in degrees on the graduated neck, so we say the density of the solution is so many degrees Beaume.

For testing and diluting lime-sulphur preparations it is necessary to have a hydrometer and a deep glass jar which will hold enough solution to float the hydrometer. The hydrometer cannot detect impurities which may have been added to the solution to increase its density. Such adulterations are rarely met with, and can be determined only by chemical analysis.

The readings on the hydrometer should be made at the general surface of the liquid in which it is supported. After each test, the instrument should be rinsed in clear water to avoid accumulations of the solution. The temperature of the lime-sulphur solution at the time of the test should be about 60 degrees Farenheit.

The lime-sulphur preparations heretofore described are to be used as indicated below:

Formula No. 3—Self-boiled lime-sulphur is recommended especially for use on peach to control brown rot and scab. Apply, as already stated, first after the husk of the bloom has withered and again four weeks later. It is also useful for plum and cherry. Formula No. 4—Lime sulphur mixture for dormant trees. This material is used on all sorts of trees while they are dormant as a remedy for the San Jose scale, preferably just before the buds open in the spring. Formula No. 5—Commercial cencentrated lime-sulphur. This is used for the same purposes as formula No. 4 and is an exceedingly convenient preparation since it is only necessary to add the required amount of water and then apply to the trees. Formula No. 6—Home-made concentrated lime-sulphur solution. This material can be used both as a summer and winter spray by diluting to the required density by the use of a Beaume hydrometer.

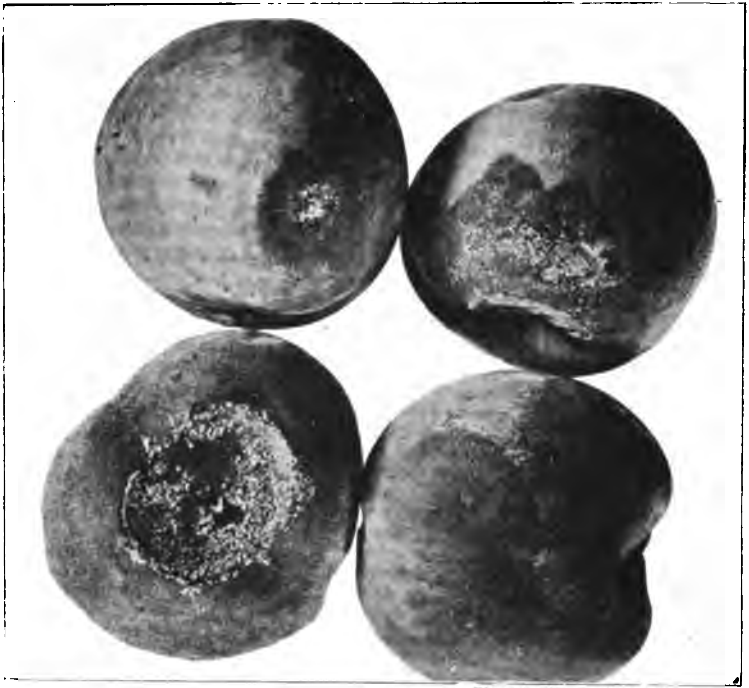

Photo by W. E. Rumsey

Brown rot of peach.

Formula No. 7—Corrosive Sublimate

Corrosive sublimate	4 oz.
Water	30 gallons

It is best to dissolve the corrosive sublimate in 2 to 3 gallons of hot water and add this solution while hot to the remainder of the water. This amount is sufficient to disinfect 25 to 30 bushels of potatoes for scab. Metal dishes must not be used for containing any corrosive sublimate solution.

A solution made up with 1 part of corrosive sublimate to 1000 parts of water is used for disinfecting wounds after pruning.

Formula No. 8—Formalin

Formalin	1 pint
Water	30 gallons

This amount is sufficient for disinfecting about 20 bushels of potatoes for scab.

Insecticides

Formula No. 4—See Fungicides

Formula No. 9—Kerosene Emulsion

Hard Soap	½ pound
Boiling Water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the water, first cutting it into thin slices to facilitate the process; remove from the stove, add kerosene, and churn through a force pump for 10 minutes. This forms a thick, cream-like stock solution. For use add 1 gallon emulsion to 10 gallons of water. For use on very young tender shoots, add 1 gallon emulsion to 15 gallons of water.

The standard formula for green lice.

Formula No. 10—Tobacco Decoction

Tobacco	2 pounds stems or dust, or 1 pound leaf
Water	2 gallons

This is a remedy for plant lice.

Steep the strength from the tobacco and then spray it on the infested plants, or dip them into the liquid. Owing to the different strength of the tobacco used in making this decoction it varies in its effectiveness.

A tobacco decoction known as "Black leaf" manufactured by the Kentucky Tobacco Product Co., Louisville, Ky., is a good material. For plant lice it is used one part to 60 or 65 parts of water.

Formula No. 11—Arsenate of Lead

Lead Arsenate or Disparene	2 pounds
Water	50 gallons

Lead arsenate is in many places taking the place of Paris Green as the standard insecticide, since it remains longer in suspension, does not burn the foliage, and adheres better to the leaf surfaces. Make a thin, smooth paste with the poison and a little water, then add the remainder of the water and stir thoroughly.

In first spray for the grape-vine flea beetle use four pounds of arsenate of lead to fifty gallons of water.

Formula No. 12—Soluble, or Miscible Oil

Soluble Oil (miscible oil)	1 gallon
Water	12 to 15 gallons

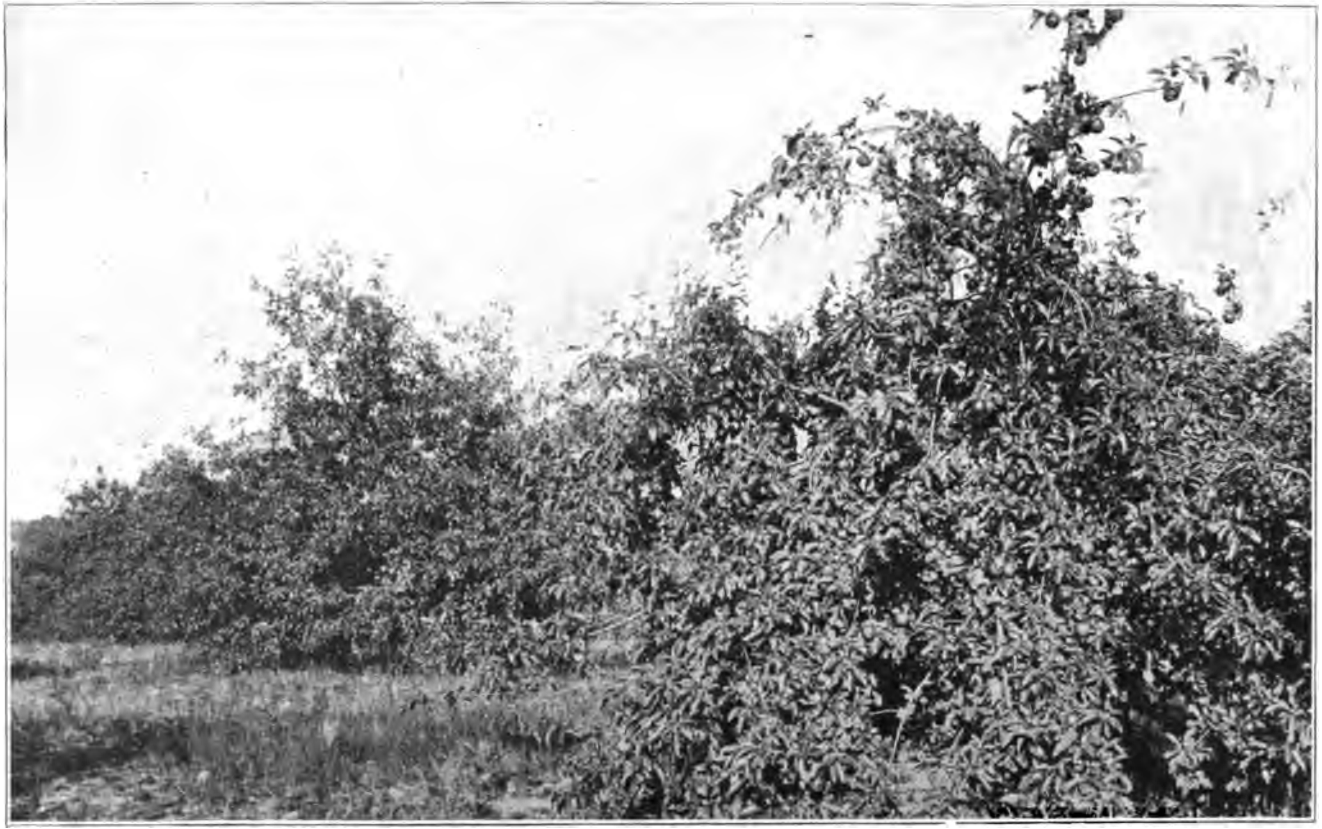

Photo by W. E. RUMSEY

Properly sprayed apple trees. Photograph taken late in September. Note dense foliage.

For the benefit of those who may contemplate the purchase of a spray outfit or spray material the following lists of reliable firms manufacturing such, are given.

SPRAY PUMP MANUFACTURERS*

Goulds Mfg. Co	Seneca Falls, N. Y.
The Deming Co	Salem, Ohio.
Field Force Pump Co	Elmira, N. Y.
Hardie Mfg Co	Hudson, Mich.
Bean Spray Pump Co	Cleveland, Ohio.
F. E. Myers & Bro	Ashland, Ohio.
E. C. Brown Co	Rochester, N. Y.
Spraymotor Co	Buffalo, N. Y.
H. L. Hurst Mfg Co	Canton, Ohio.
Wm Stahl Sprayer Co	Quincy, Ill.
Friend Mfg Co	Gasport, N. Y.
Morrill & Morley	Benton Harbor, Mich.
Barnes Mfg Co	Mansfield, Ohio.
R. H. Deyo & Co	Binghampton, N. Y., Power outfits only.
The New Way Motor Co	Lansing Mich., Power outfits only.
Bateman Mfg Co	Greenloch, N. J. Potato Sprayers.
Aspinwall Mfg Co	Jackson, Mich. Potato Sprayers.
Pierce-Loop Co	Northeast, Pa. Compressed Air Sprayers.

MANUFACTURERS OF SPRAY MATERIALS*

Grasselli Chemical Co	Pittsburg, Pa. & Cleveland, O.
Thomsen Chemical Co	Baltimore, Md.
Horticultural Chemical Co	Philadelphia, Pa.
Sherwin, Williams Co	Cleveland, Ohio.
Rex Co	Omaha, Neb., Conc. Lime-Sulphur Solution.
Merrimac Chemical Co	Boston, Mass., Arsenate of Lead
Hemingway & Co	New York N. Y., Arsenate of Lead.
B. G. Pratt Co	New York, N. Y. Scalecide, Sulphocide.
Bowker Insectitide Co	Boston, Mass.
Vreeland Chemical Co	New York, N. Y.
Batelle & Renwick	New York, N. Y. Sulphur.
Bergenport Sulphur Works	New York, N. Y. Sulphur.
The Kentucky Tob. Product Co	Louisville, Ky. Tobacco Extracts.

*NOTE.—Except where stated, the above mentioned firms handle a general line of spray apparatus and material.

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BULLETIN 134 JUNE, 1911

Experiments in the Production of Sanitary Milk.

HORACE ATWOOD AND N. J. GIDDINGS.

[The Bulletins and Reports of this Statian will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W. Va.]

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Experiments in the Production of Sanitary Milk.

When milk remains at ordinary temperatures it usually sours and soon becomes unfit for food. This change is brought about by the growth within the milk of minute organisms called bacteria. Cooling the milk and holding it at a low temperature hinders the development of the germs, for a few days at least, thus enabling this valuable food material to reach the consumer in good condition.

The common system of cooling milk consists in allowing it to run over the surface of a corrugated metal cooler, through the interior of which is circulated the cooling medium, either cold water or cold brine. In Bulletin No. 111 of this Station there is a discussion of the necessity for the thorough cooling of milk that is intended for direct consumption, and the adaptability of a system of artificial refrigeration for this purpose has been pointed out.

In connection with the work reported in that bulletin, the question developed as to possible bacterial contamination of the milk from the cooler itself. The investigations described in the following pages were undertaken primarily for the purpose of securing information in regard to this point. As the work progressed, numerous other questions were encountered, and some of them were studied sufficiently to at least give some idea of their importance and suggest methods for further study.

EXPERIMENTAL WORK

Most of the milk samples used for this work were taken in large-mouthed glass-stoppered bottles, holding about 8 ounces each. Strong heat-resistant paper was wrapped about the upper part of each bottle and tied down close around the neck. They were then sterilized in an oven at 190° to 200° C for 2 to 5 minutes, and were used within a few days.

In some cases the entire milk from a given quarter was taken as a sample and enamel ware milk cans of 1 gallon capacity were used for such samples. The cover of each can was wrapped in cotton and placed in a small sheet iron box, while the top of the can was carefully covered with two sheets of paper tied on. The cans and covers were sterilized in an oven as described above.

Samples were received at the laboratory within 1½ to 2½ hours after taking. They were thoroughly shaken, using both a rotary and a vertical movement. Dilutions were made into flasks of sterile distilled water and shaken, using rotary movements. One cubic centimeter of this dilution was added to 10 c. c. of agar or gelatin, and plates poured at once. In all cases, unless otherwise stated, there was one agar plate and one gelatin plate poured for each dilution. The plates were incubated at 18° to 20° C and counts made after 3 to 4 days. In some cases the number of colonies on a plate was too great to count, and a portion, 1 square centimeter to one-fifth of the plate area was counted, and the total number of colonies estimated from that. It will be seen that the bacterial content stated for nearly every sample is an average of counts from four poured plates.

THE MILK COOLER AND BOTTLING MACHINE AS A SOURCE OF BACTERIAL CONTAMINATION

The cooling apparatus employed is of the usual type and is shown in Fig. 1. During the tests reported in tables I and II it was washed as is customary, first with lukewarm water, then with hot water to which washing compound was added, and finally rinsed with scalding water.

In taking the samples of uncooled milk a 20 quart can of warm milk was poured into the vat located above the milk cooler and the sample taken at once by means of a sterile cup. The milk was then allowed to run over the cooler and the samples of cooled milk taken after the milk had collected in the tank of the bottling machine. The samples of uncooled milk were then placed in ice water for a time so as to cool the milk to practically the same temperature as the other samples.

The following table shows the germ content of the milk before and after it was run over the cooler. In these tests the cooler was freely exposed to the air of the dairy room.

Table I Bacterial Counts of Milk Before and After Passing Over Cooler Nov. 20-26, 1907.*

Sample	Bacteria Total	Rapid Liquifiers	% Rapid Liquifiers	Slow Liquifiers	% Slow Liquifiers	Moulds	Count is Probably	Remarks
	BACTERIA					MOULDS		
11-20 Uncooled	1,240	65	5.5	33	2.2	325	Fairly accurate	
11-20 Cooled	18,200	165	0.9	125	0.7	425	3500 Low	Liquifiers forced early counting
11-21 Uncooled	1,580	65	4.2	185	11.5	100	400 High	
11-21 Cooled	4,300	190	4.5	100	2.3	450	200 High	
11-22 Uncooled	10,380	33	0.3	570	5.5	34	Fairly accurate	
11-22 Cooled	39,650	290	0.7	285	0.7	125	Too low	
11-23 Uncooled	11,670	90	0.8	185	1.6	0	Slightly low	Early liquifaction of 2 plates
11-23 Cooled	13,800	65	0.5	50	0.4	135	Low	Early liquifaction of 3 plates
11-25 Uncooled	20,400	0	0.0	250	1.2	17	Accurate	
11-25 Cooled	17,400	0	0.0	800	4.7	25	Fairly accurate	
11-26 Uncooled	18,900	33	0.2	160	0.8	17	Trifle low	
11-26 Cooled	19,200	140	0.7	235	1.2	110	Trifle low	
Average Cooled	18,750							
Average Uncooled	10,700							

*These determinations were made by Mr. C. P. Hartley while he was associated with this Station.

MILK BEFORE AND AFTER PASSING OVER COOLER

Table II Cooler Not Enclosed

DATE	No. of Sample	Treatment	Dilutions Used	Bacteria per cc.
April 24, 1909......	1	Uncooled	250 & 500	229000
April 24, 1909......	2	Cooled	250 & 500	254000
April 28, 1909......	3	Uncooled	500 & 1000	4250
April 28, 1909......	4	Cooled	500 & 1000	6100
April 29, 1909......	5	Uncooled	500 & 825	7200
April 29, 1909......	6	Cooled	500 & 1000	8200
May 3, 1909.......	7	Uncooled	500 & 1000	6400
May 3, 1909.......	8	Cooled	500 & 1000	9200
May 10, 1909......	9	Uncooled	500 & 1000	1250
May 10, 1909.......	10	Cooled	500 & 1000	2100
May 17, 1909......	11	Uncooled	250 & 500	1600
May 17, 1909......	12	Cooled	250 & 500	1900
May 25, 1909.......	13	Uncooled	125 & 250	8000
May 25, 1909......	14	Cooled	125 & 250	16000
May 26, 1909.......	15	Uncooled	125 & 250	4000
May 26, 1909......	16	Cooled	125 & 250	4000

Average No. of bacteria in uncooled samples, 32.700.
Average No. of bacteria in cooled samples, 37,700.

These results show that in practically every case the number of bacteria in the milk was greater after it had been passed over the cooling apparatus than it was before. Since the prime object in using a milk cooler is to keep down the bacterial content, it would seem essential to prevent these germs from accumulating upon the apparatus itself. For the purpose of eliminating such bacteria as were not removed or destroyed by the ordinary washing processes, it seemed as though some method of applying live steam directly to the appartus, would be most efficient and practical. A practically steam-tight compartment was therefore constructed so as to enclose the milk cooler and bottling machine. It was constructed in the form of a box, and was provided with suitable doors for the convenient operation and washing of the equipment. To prevent rusting the interior was lined with tinned sheet copper.

After the cooler and bottling machine had been enclosed, as shown by Figs. 2 and 3, instead of rinsing with scalding water live steam was used, the steam being turned into the little room or enclosure surrounding the cooler and bottling machine for about fifteen minutes. The apparatus was steamed after it had been used and washed, and the doors of the enclosure were not opened until the cooler and bottle filler were to be used again.

Table III gives the results of the tests after the cooler and bottling machine had been enclosed.

MILK BEFORE AND AFTER PASSING OVER COOLER

Table III Cooler Enclosed

DATE	No. of Sample	Treatment	Dilutions Used	Bacetria per cc.
October 1, 1909...	17	Cooled	200 & 1000	17800
October 1, 1909....	18	Uncooled	200 & 1000	16800
	19-22	Omitted	as plates	spoiled.
December 12, 1909..	23	Cooled	125 & 500	930
December 12, 1909.	24	Uncooled	125 & 500	1800
December 28, 1909..	25	Cooled	50 & 200	600
December 28, 1909..	26	Uncooled	50 & 200	550
January 6, 1910....	27	Cooled	10 & 50	1450
January 6, 1910....	28	Uncooled	10 & 50	1400
January 15, 1910....	29	Cooled	10 & 50	3700
January 15, 1910....	30	Uncooled	10 & 50	4000

Average No. of bacteria in cooled sample, 4900.
Average No. of bacteria in uncooled sample, 4910.

It is evident from the above figures that the cooling and bottling apparatus ceased to be a source of contamination after it had been properly enclosed and given a careful steaming each day. In order to further test the efficiency of this treatment, a series of trials were planned allowing sterile water instead of milk to flow over the cooler. The method of procedure was as follows: A 2-liter glass stoppered bottle was carefully filled with boiling hot water, a bit of string placed inside the neck of the bottle and allowed to hang down 5 or 6 inches on the outside, and the stopper dropped in loosely against the string. The top of the bottle was carefully wrapped with cotton, and then the bottle was placed in an autoclave and heated for 45 to 60 minutes at 15 to 20 pounds steam pressure. After the bottle was taken out and allowed to cool, the string between stopper and bottle was pulled out allowing the stopper to drop in tight so as to prevent slopping in carrying bottle. In removing the string, care was exercised not to touch either the stopper or disturb the cotton wrapping.

Four such bottles were used for each test. They were taken to the dairy within 24 to 48 hours after sterilization, unwrapped, and the contents of the four bottles poured into the little tank located immediately above the cooler. The water was then allowed to flow over the cooler into the bottling machine. After all of the water had collected in the tank of the bottling machine the mouth of a sterile sample bottle was pressed against one of the valves of the bottling machine and allowed to fill in the usual way.

The following table gives the bacterial content of the water after passing over the cooler and through the bottling machine.

Table IV Bacteria on Cooler

COOLER ENCLOSED AND STEAMED DAILY		COOLER LEFT OPEN AND MERELY WASHED AND SCALDED	
DATE	Bacteria per cc.	DATE	Bacteria per cc.
October 1, 1909....	2	April 22, 1910..........	1030
Ocotber 14, 1909....	1	April 23, 1910..........	8720
December 10, 1909..	1	April 27, 1910..........	3720
December 28, 1909..	1	April 28, 1910..........	16400
January 6, 1910....	8	April 29, 1910..........	21900
January 15, 1910....	1		
Average No.....	2	Average No........	11400

From the three series of experiments previously described, we feel reasonably safe in concluding that the ordinary milk cooling devices are not nearly so efficient as they should be for keeping down the bacterial content of milk, but that by properly enclosing such apparatus and subjecting it to live steam as described above, it ceases to be a source of contamination, and the beneficial effects of cooling are much greater.

It is evident from the results secured on Jan. 6, 1910, that the steam treatment was not continued quite long enough. It must also be remembered that the steaming does not in any way reduce the necessity for thorough washing. In order to secure good results the apparatus must be carefully enclosed so that the steam is retained in the chamber and the live steam must be permitted to run into the chamber for a sufficient length of time to heat the articles to the boiling point of water and maintain that temperature for 15 to 20 minutes.

In some cases it may be difficult to determine just how long steam ought to be admitted into the enclosure in order to sterilize the apparatus, but when in doubt it is a good practice to steam a few minutes longer. A potato the size of a hen's egg may be used as a fairly good indicator. If the potato is placed in an open dish midway between the ceiling and the floor of the enclosure, the steam should be admitted until it is fairly well cooked through. The length of time required for any sized enclosure and steam pressure can be determined in this way by one or two trials.

(A) RELATIVE NUMBER OF BACTERIA IN DIFFERENT PORTIONS OF MILK FROM SAME PART OF UDDER

A few tests were made in order to secure some data as to the relative numbers of bacteria occurring in the first milk drawn, in that taken when about half the milk had been secured, and in the strippings. For this work, the sterile glass stoppered bottles were used and two sets of samples were taken for each test, one from the hind quarters and the other from the front quarters.

In taking the samples of milk directly from the udder great care was exercised to prevent bacteria from external sources entering the milk. The hair on the cow's udder and flanks was kept closely clipped, and immediately before each sample was taken the teats, udder and flank were thoroughly washed with an antiseptic solution, usually two per cent Chloronaptholeum, and wiped with a sterile towel until no superflous moisture remained. Then a paper cap was removed from a sample bottle and, while holding the bottle in a horizontal position with the right hand, the glass stopper was grasped by the index and middle finger of the left hand, removed from the bottle, and carried underneath it, the left hand grasping the bottle, thus leaving the right hand free to do the milking. The sample bottles were maintained in as nearly a horizontal position as possible until the sample had been obtained and the stopper inserted. The paper cap was then put in place.

The first set of samples consisted of only one sample from the hind quarters and one sample from the front quarters, being portions of the entire milk secured from these quarters. The results are given in the following table.

Table V Bacteria in Different Portions of Milk From Same Quarters.

BACTERIA PER CUBIC CENTIMETER

	Hind Quarters			Front Quarters			Remarks
Dilution	50	2	50	50	2	50	
Date	1st Milk	Mid. Milk	Strippings	1st Milk	Mid. Milk	Strippings	
Feb. 26, '10	....	250	....	....	2080	....	Dilutions used here were 5 & 25
Mar. 2, '10	200	85	150	6000	1300	....	Front stripping ommitted by mistake
Mar. 3, '10	200	14	50	2550	65	2200	
Mar. 5, '10	Less Than 50	38	100	2000	160	1150	
Mar. 7, '10	Less Than 50	3	75	4200	26	1600	

These tests serve to bring out the fact that the first milk and the strippings contain far more bacteria than that taken between these portions. It must not be assumed, however, that, since the strippings contain a larger number of germs, this portion of the milk should be left. Stocking has shown* that careful stripping keeps the bacterial content of milk low, while leaving a little milk in the udder from one milking to the next nearly doubled the number of bacteria per c. c. It is a matter of general belief among dairymen that the careless stripping of cows has a tendency to decrease the production of milk to a considerably greater extent than can be accounted for by the small amount of milk left in the udder at each milking. Whether this decreased yield is brought about through the increase in the bacterial content of the udder, or in some other way remains to be determined.

(B) RELATIVE NUMBERS OF BACTERIA IN DIFFERENT QUARTERS OF UDDER, AND RELATION OF BACTERIAL CONTENT AND MILK YIELD

Several series of samples were taken for the purpose of making some determinations as to the number and distribution of bacteria normally present in the cow's udder. The first set of samples were taken in gallon, enamel ware milk cans. These cans were sterilized and handled as described on page 84 and one can was used for each quarter. The samples for all other trials were taken in the glass stoppered bottles prepared as described on page 84.

For these smaller samples, an aliquoit portion of the milk from each quarter was obtained by milking every third fourth, or fifth stream into the bottle, the other streams being milked into another receptacle.

On each of three dates the amount of milk from each quarter was carefully weighed, in order to learn if there was any relation between the amount of milk secreted and the number of bacteria per cubic centimeter.

The results of these tests are given in the following table:

***Stocking, W. A., Jr., Conn. (Storrs) Exp. Sta. Report 18 (1906) p. 85.**

Table VI Number of Bacteria and Amount of Milk from Different Quarters.

Date	HIND QUARTERS				FRONT QUARTERS				Remarks
	LEFT		RIGHT		LEFT		RIGHT		
	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	
Mar. 14, '10	5 & 25	60	5 & 25	55	20 & 100	625	20 & 100	8000	Entire milk taken for each sample.
Mar 17, '10	5 & 25	44	5 & 25	55	20 & 100	40	20 & 100	10500	Portion of milk taken for each sample.
Mar. 18, '10	5 & 25	70	5 & 25	50	20 & 100	85	20 & 100	12100	Portion of milk taken for each sample.
Mar. 21, '10	5 & 25	100	5 & 25	55	20 & 100	110	20 & 100	8400	Portion of milk taken for each sample.
Mar. 22, '10	5 & 25	33	5 & 25	50	20 & 100	20	50 & 200	1900	Portion of milk taken for each sample.
Mar. 26, '10	5 & 25	....	....	....	10 & 50	90	50 & 250	3500	Portion of milk taken for each sample.
Mar. 29, '10	5 & 25	25	5 & 25	32	5 & 25	50	50 & 125	9900	Portion of milk taken for each sample.

	Weight of Milk	Weight of Milk	Weight of Milk	Weight of Milk
Mar. 14, '10	5.3 lb. or 2405 grams	5 lb or 2270 grams	2.52 lb. or 1140 grams	1.43 lb. or 650 grams
Mar. 24, '10	5.6 lb. or 2542 grams	4.9 lb. or 2222 grams	1.95 lb. or 885 grams	1.4 lb. or 636 grams
Mar. 25, '10	5.85 lb. or 2656 grams	4.87 lb. or 2211 grams	1.92 lb. or 872 grams	1.52 lb. or 690 grams

These figures show a very pronounced difference both in amount of milk, and bacteria per c. c. from the different quarters of the udder, but the order of differences exhibited in one table are reversed in the other. That is, where the number of bacteria is high the amount of milk is small and where the number of bacteria is small the amount of milk is large. In order to bring out this fact more clearly, and shown the approximate total number of bacteria contained in all the milk from any quarter, another tabulation is given below. The averages were obtained from the data given in the previous table.

As the average specific gravity of milk is about 1.035, the amount in grams was divided by that factor to determine the equivalent amount in cubic centimeters.

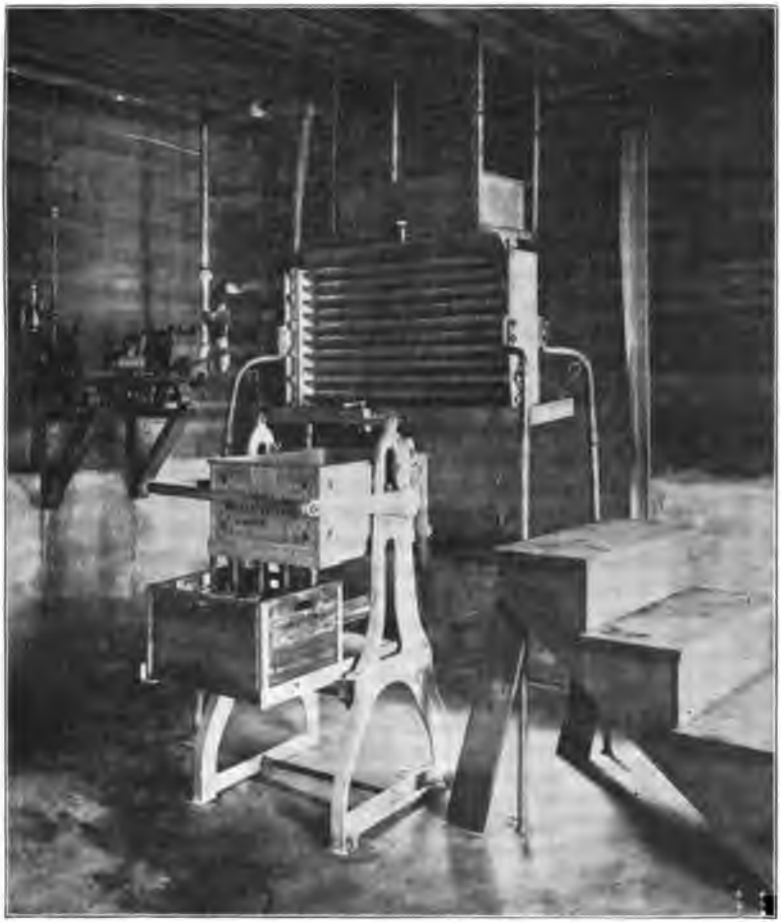

Fig. 1.—Milk Cooler and Bottling Machine as Originally Installed.

OF M

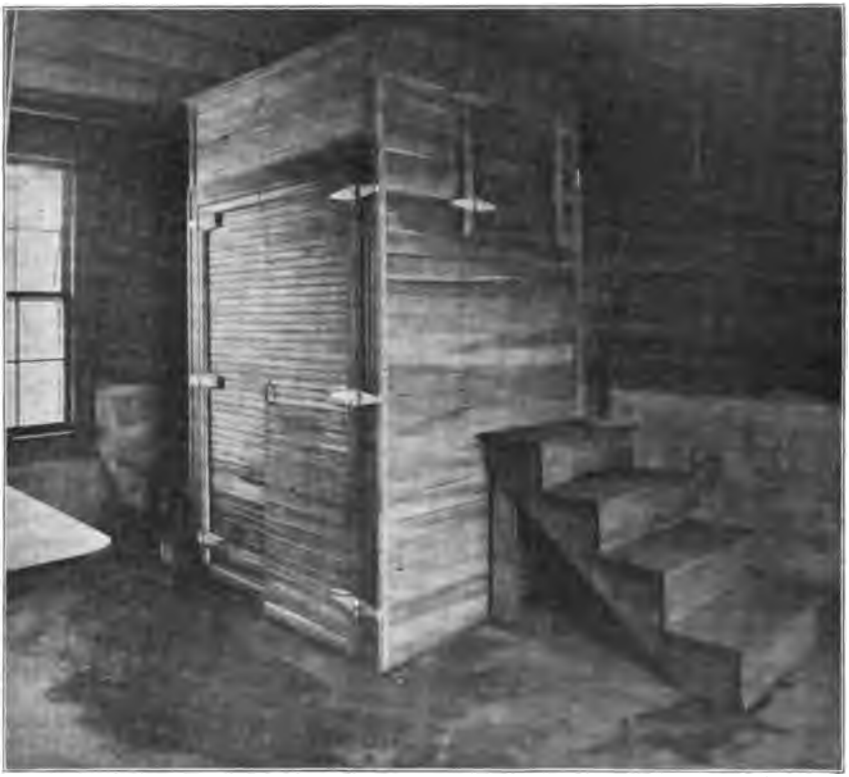

Fig. 2—Milk Cooler and Bottling Machine Boxed In.

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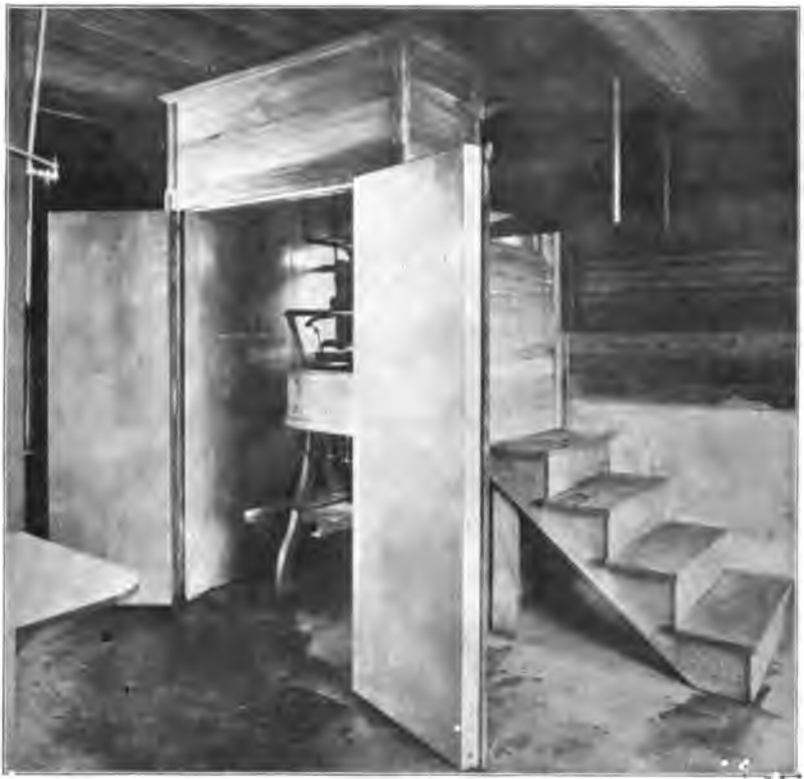

Fig. 3.—Doors Open Ready for Operation.

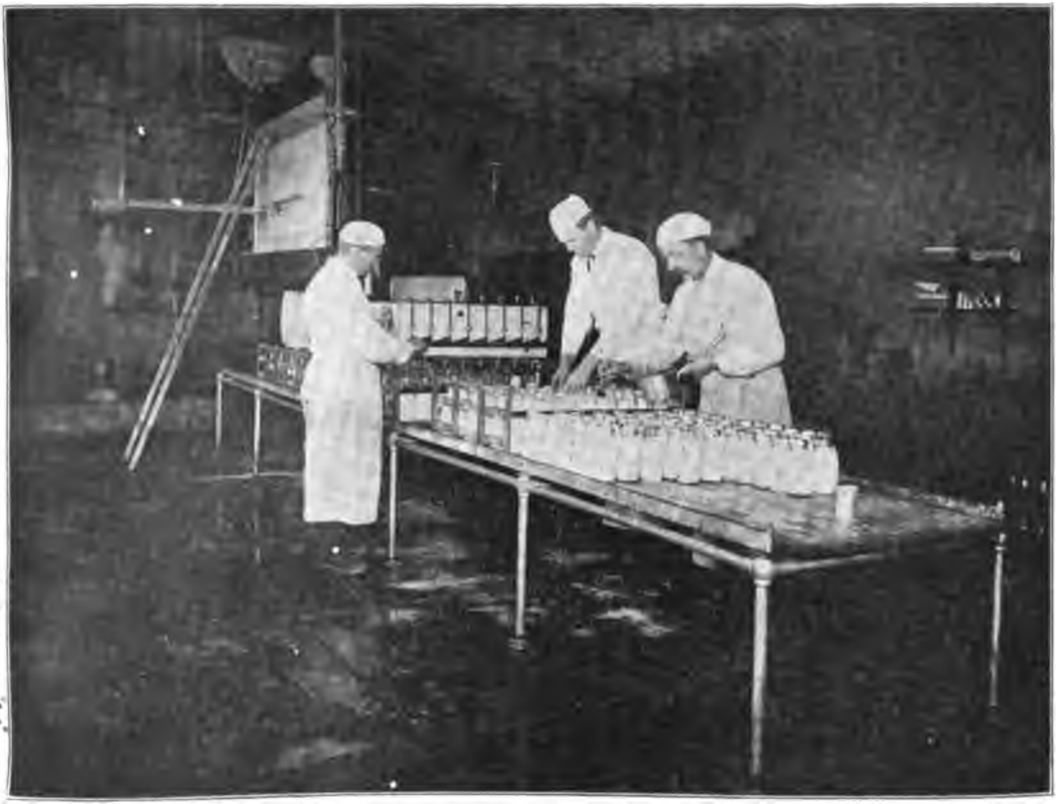

Fig. 4.—Milk Room, Walker Gordon Laboratory Co., Plainsboro, N. J.

Note the sanitary construction. Visitors are not allowed to enter this room. The milk cooler is exposed. A typical up-to-date plant.

Table VII

	HIND QUARTERS		FRONT QUARTERS	
	Left	Right	Left	Right
Average weight of milk in grams	2,534	2,234	966	659
*Approximate equivalent in cubic centimeters	2,448	2,158	933	643
Average No. of bacteria per c. c.	55	50	145	7,760
Total bacteria in milk from quarter	134,600	105,900	135,300	4,990,000

*The average specific gravity of milk is taken as 1.035 for this determination.

The above results indicate the extreme importance of watching not only the cow but each quarter of her udder in the production of high grade milk. For instance, if the milk from only the rear quarters is taken there is 10.5 pounds of very high grade milk carrying only about 53 bacteria per c. c., and if only that from the front quarters is taken there is 3.6 pounds of milk carrying about 3250 bacteria per c. c., while bringing together the milk from all four quarters we have 14.1 pounds of milk with a bacterial content of about 870 per c. c.

In conducting our experimental work with other cows similar variations were found in the milk from the different quarters, (see tables V, VIII, IX, X, and XIII). Some further investigations would be especially desirable along this line, but from the results of our work, we believe that it would pay the producers of certified milk to make frequent tests of the bacterial content of each quarter of every cow's udder and use the milk having a high germ content for purposes other than for direct consumption.

CAN THE HIGH GERM CONTENT OF A CERTAIN QUARTER OF A COW'S UDDER BE REDUCED?

In hope of finding some practical method to reduce the number of bacteria present in any given quarter of the udder. the three series of experiments described below were undertaken.

I. Sealing the opening of the teat so as to exclude possible external contamination.

After the udder had been thoroughly stripped the end of the teat to be sealed was dried with a sterile towel and then moistened with 25 per cent lysol. This was wiped off and carbolated vaseline rubbed onto the end of the teat. To protect the vaseline pieces of adhesive tape, three or four inches long were used so as to completely cover the end of the teat. The teats were sealed after every milking, but samples were secured only from the morning's milk and were taken in sterile glass stoppered bottles as previously described.

The following table gives the results of the tests:

Table VIII Teat Sealing Experiment

DATE	SEALED QUARTER		OPEN QUARTER		Remarks
	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	
COW No. 4					
January 27, 1910	10 & 100	21200	10 & 100	400	Front quarter sealed.
January 28, 1910	10 & 100	2800	10 & 100	400	Front quarter sealed.
January 29, 1910	10 & 100	100	10 & 100	100	Front quarter sealed.
January 31, 1910	10 & 50	3300	10 & 50	250	Front quarter sealed.
COW No. 9					
February 1, 1910	10 & 50	900	10 & 50	10	Front quarter sealed.
February 2, 1910	10 & 50	700	10 & 50	65	Front quarter sealed.
February 3, 1910	10 & 50	1200	10 & 50	75	Front quarter sealed.
February 4, 1910	5 & 50	1500	5 & 50	40	Front quarter sealed.
February 5, 1910	5 & 25	320	5 & 25	30	Front quarter sealed.
February 7, 1910	5 & 25	320	5 & 25	110	Front quarter sealed.
February 9, 1910	5 & 25	440	5 & 25	200	Front quarter sealed.
February 11, 1910	5 & 25	440	5 & 25	60	Front quarter sealed.
February 14, 1910	5 & 25	110	10 & 25	1360	Rear quarter sealed.
February 16, 1910	5 & 25	130	5 & 25	1110	Rear quarter sealed.
February 17, 1910	5 & 25	20	5 & 25	2100	Rear quarter sealed.
February 18, 1910	5 & 25	40	5, 10 & 25	1170	Rear quarter sealed.
February 21, 1910	5 & 25	30	5 & 25	1910	Rear quarter sealed.

It would seem that carefully sealing the teat with carbolated vaseline after milking reduced the number of bacteria somewhat, but such a procedure could hardly be recommended without a more complete series of tests.

II Injecting the udder with dioxygen in order to destroy, wash out or hinder the development of bacteria.

For this work flasks of sterile distilled water were prepared as follows: Some 300 c. c. flasks were used, and 250 c. c. of distilled water poured into each, they were then set on a table and the height of the water was carefully marked on the outside, then 50 c. c. of water were poured out, the flasks plugged with cotton, and sterilized in an autoclave at 15 pounds steam pressure for 15 to 20 minutes. When about to be used, Dioxygen was added to the sterile water till the fluid was even with the marks on the side of the flask, thus making an approximate 20 per cent solution.

The injections were carried out as follows,—A milking tube was connected by a rubber tube to a wash bottle provided with a compression bulb so that the contents of the bottle could be forced through the milking tube. Before use the entire apparatus was sterilized by boiling. Before the injections were made the end of the teat was moistened with 25 per cent lysol. Then the milking tube was inserted into the milk duct and connections made with the wash bottle to which the solution had been transferred. In these tests the solution was used at ordinary room temperature. As the dioxygen seemed to be somewhat irritating it was milked out as completely as possible after it had remained in the udder for one minute. Injections were made on March 29th and 30th in the evening, and the samples of milk taken the next morning.

The following table gives the results of the tests:

Table IX Dioxygen Treatment Results

Date	HIND QUARTERS				FRONT QUARTERS				Remarks
	LEFT		RIGHT		LEFT		RIGHT		
	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	
Mar. 26, '10	....	....	....	....	10 & 50	90	50 & 250	3500	
Mar. 29, '10	5 & 25	26	5 & 25	32	5 & 25	50	50 & 125	9900	
Mar. 30, '10	....	....	....	....	5 & 25	35	2, 9 & 50	490	Right Front injected with dioxygen Mar. 29. Milk noticeably yellow (6 plates).
Mar. 31, '10	....	....	....	....	5 & 25	40(a)	2 & 25	335(b)	Treated Mar. 30 as before. Milk very yellow.
Apr. 1, '10	....	....	....	....	5 & 25	25	2 & 25	610	Milk quite yellow.
Apr. 2, '10	....	....	....	....	5 & 25	45	25 & 125	39000	Milk noticeably yellow.
Apr. 6, '10	....	....	....	....	9 & 25	160	50 & 250	4600	Milk normal color.
Apr. 7, '10	....	....	....	....	5 & 25	145	50 & 250	8000	Milk normal color.

(a) Milk curdled in 48 hours.
(b) Milk was not curdled after 7 days.

The above treatment produced a remarkable diminution in the number of bacteria, but the fact that it causes irritation renders it useless, since the numbers shortly after ceasing the injections are vastly greater than they were in the first place, and the quarters became slightly inflamed following the treatment.

III Injecting the udder with glycothmoline for the purpose of destroying, washing out or hindering development of bacteria.

Flasks of sterile distilled water were used in this work, and were prepared similar to those described in the Dioxygen experiments, 200 c. c. of water being placed in the flask to start with and the final solution of Glyco-Thymoline being 25 per cent. The solution was injected at blood heat immediately after milking in the evening. It was allowed to remain in the udder for one hour, and was then milked out as completely as possible.

Table X Glycothymoline Treatment and Results

DATE	HIND QUARTERS				FRONT QUARTERS				Remarks
	LEFT		RIGHT		LEFT		RIGHT		
	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	Dilutions Used	Bacteria per cc.	
June 7, '10	20 & 100	No colonies on plates	20 & 100	70	100 & 500	300	100 & 500	9150	
June 8, '10	10 & 100	10	10 & 100	20	20 & 100	45	20 & 100	8170	
June 9, '10	20	40	20	170	20 & 100	100	20 & 100	3320	
June 10, '10	....	....	....	....	10 & 100	205	10 & 100	610	R. F. Quarter Injected evening June 9.
June 11, '10	....	....	....	....	10 & 100	145	5 & 50	1610	Injected as previously.
June 13, '10	....	....	....	....	5 & 50	380	5 & 50	1040	Injected as previously.
June 14, '10	....	....	....	....	5 & 50	145	5 & 50	1260	Injected as previously.
June 15, '10	....	....	....	....	5 & 50	85	5 & 50	3230	
June 16, '10	....	....	....	....	5 & 50	60	5 & 50	8930	Two R. F. plates had great No. of colonies.
June 18, '10	....	....	....		5 & 50	130	10 & 100	5700	
Nov. 14, '10	5 & 100	410	5 & 100	41800	100, 10000 & 50000	183500	5, 100 & 500	64400	
Nov. 15, '10	5 & 100	3340	5 & 100	31200	100 & 2000	233600	100 & 2000	84600	
Nov. 16, '10	4 & 100	1710	....	....	100 & 2000	623900	100 & 2000	45500	
Nov. 17, '10	5 & 50	1530	10 & 200	16400	100 & 2000	326600	....	....	
Nov. 18, '10	5 & 100	1460	....	....	100 & 2000	2227000	100 & 2000	109700	L. F. and R. F. Injected evening Nov. 20.
Nov. 21, '10	5 & 50	4460	....	....	500 & 5000	370000	500 & 5000	7500	
Nov. 22, '10	5 & 50	6100	....	....	200 & 2000	20300	20 & 2000	5800	"
Nov. 23, '10	5 & 50	2300	....	....	50 & 500	17500	50 & 500	13500	"
Nov. 24, '10	5 & 50	6000	....	....	50 & 500	39100	50 & 500	8400	"
Nov. 25, '10	5 & 50	1700	....	....	50 & 500	1974000	50 & 500	34700	No injection last evening.
Nov. 26, '10	5 & 50	1000	....	....	50 & 500	24000	50 & 500	19000	
Nov. 28, '10	100	2400	....	....	100 & 500	3790000	100 & 500	4040000	
Dec. 1, '10	10 & 100	2400	....	....	100 & 10000	3560000	100 & 10000	1855000	

Here again it is evident that there was a considerable reduction in the number of bacteria from injected quarters, but that after the treatment had been stopped the numbers soon became as great or greater than they were before. During the first series of trials, June, 1910, there was no sign of injury to the udder as a result of the injections, and it had been planned to have the second series extend over a much longer period of time, but after four injections the quarter used was showing some inflammation and the treatment had to be stopped. As a result of the irritation induced at this time, the bacterial content of that quarter rose to 4 million per c. c. within three days after the last injection was used. The inflammation gradually subsided in three or four days after the injections were discontinued.

While these experiments did not give us the desired results, we believe that a great deal more work should be undertaken along these lines, and that something of considerable practical value will eventually be learned.

How Nearly Germ-free Can Milk Be Obtained?

If the bacterial content of the milk from each quarter be determined, and those quarters selected which usually run low in germs, how nearly germ-free can milk be produced commercially? A few tests were carried out with the cow used in the teat sealing experiment, the milk from the rear quarters only being saved. The first few streams were rejected from these quarters and the remainder milked into a sterile pail provided with a small top and held in a somewhat horizontal position while milking. The very last part of the strippings was not included in the samples. The following table gives the details of these tests. Each sample consisted of about two quarts of milk.

Table XI Results of Experiment to Determine How Nearly Sterile Milk Can be Drawn from Udder

DATE	Dilutions Used	Bacteria per cc.	Remarks
February 5, 1910...	1 & 10	120	6 plates poured.
February 7, 1910..	1 & 2	6	
February 11, 1910...	1 & 2	8	
February 14, 1910...	1 & 2	19	
February 16, 1910...	1 & 2	25	
February 26, 1910..	1 & 2	35	Only 2 plates poured.

Average number of bacteria per cc. 35.

These six samples of milk contained an average of 35 bacteria per c. c. That there remains vast opportunity for improvement in the production of more sanitary milk on the part of dairymen is shown by comparing these results with the figures given in the following table which gives the average number of bacteria per c. c. found in the commercial milk supplied to the city of Rochester, N. Y., during the years 1900 to 1904, inclusive. In this connection it should be remembered that Rochester takes high rank among the cities of this country in respect to the purity of its milk supply, due to the efficient supervision exercised by its officials.

Table XII Average Number of Bacteria Per cc. Found in Milk at Rochester, N. Y. *

Month	1900				1901				1902				1903				1904			
	Average per cc.	Total No. Cultures	Over 5,000,000	Under 100,000	Average per cc.	Total No. Cultures	Over 5,000,000	Under 100,000	Average per cc.	Total No. Cultures	Over 5,000,000	Under 100,000	Average per cc.	Total No. Cultures	Over 5,000,000	Under 100,000	Average per cc.	Total No. Cultures	Over 5,000,000	Under 100,000
January.......	755,971	25	5		296,100	24		9	191,989	48	1	17	190,272	46		26	164,081	44		21
February.....	137,361	29			293,839	25	2	3	155,948	44	2	24	96,105	40	1	26	106,462	48		32
March.........	189,424		12		176,200	24		10	41,975	47	3	27	220,812	42	2	10	256,363	46	1	21
April..........	No examination				402,735	24	7	4	345,609	45	2	7	163,166	45	2	23	226,958	43	1	21
May...........	820,281	35	2	12	415,504	24	8	2	409,651	48	3	14	189,825	47		8	303,186	45	2	13
June...........	666,628	33	2	9	468,066	23	4	3	258,186	47	5	18	280,628	43	3	2	315,827	44	3	18
July...........	426,209	33	5	8	326,285	24	4	5	232,614	46	2	5	174,151	29	3	9	328,231	45	3	13
August........	1,571,481	33	4		325,325	24		3	243,558	47	4	9	362,357	28	2	5	577,204	45	1	9
September....	950,213	22	5	2	161,029	24		11	298,996	23	2	1	209,655	29		4	259,845	31		15
October........	891,431	34	6	6	139,461	23		13	147,955	46	2	21	359,372	47	1	10	213,287	48		33
November....	548,961	24	4	1	103,959	24	2	10	100,814	42	2	24	116,223	47	1	23	181,397	47		30
December....	1,403,191	24			195,422	24	1	9	163,789	48		18	95,047	49		41	111,888	48		27
			10%	15%			9%	28%			6%	84%			3%	38%		2%		47%
Average....	796,468	319	33	55	275,327	287	28	82	215,917	531	26	185	204,801	492	15	187	253,727	534	11	253

* Geo. W. Goler, Health Officer of Rochester, N. Y. American Medicine, Vol. X, No. 17.

BACTERIA IN THE FIRST MILK TAKEN FROM A COW

It seemed desirable to learn whether or not bacteria were present in colostrum, or first milk, drawn from a heifer with her first calf. The calf was removed before it had opportunity to suck and the samples secured in the usual way.

The dilutions used for the first set of samples were 1 to 1, 1 to 100 and 1 to 1000; for the second set, 1 to 1 and 1 to 100; and for the third and fourth sets 1 to 2 and 1 to 10. The results are given below:

Table XIII

Date	HIND QUARTERS		FRONT QUARTERS	
	Left	Right	Left	Right
	Bacteria per cc.	Bacteria per cc.	Bacteria per cc.	Bacteria per cc.
Feb. 21, 1910.......	150	190	220	95
Feb. 22, 1910.......	180	75	100	35
Feb. 24, 1910.......	40	60	220	70
Feb. 26, 1910.......	210	460	3350	1400

We had presumed that there would either be a very large number or else practically none, as they would be expected to multiply very rapidly after they had gained entrance, and were not being removed by milking. In this case, however, there was just an average number of organisms present, and they showed a greater tendency to increase in the front quarters than in the hind. In the case of every cow with which we have made tests involving front and rear portions of the udder separately, a very much higher count has been found in milk from the front than in milk from the hind quarters. We know that some other investigators have not secured simliar results and doubtless a very large series of tests would be required in order to obtain reliable data on that point.

The experimental results given in this bulletin are considered as largely in the nature of a preliminary report. It is believed, however, that some valuable practical information has been secured, and that some of the data given, may be of service in future investigations.

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WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
MORGANTOWN, W. VA.

BULLETIN 135 SEPTEMBER, 1911

West Virginia As a Poultry State

HORACE ATWOOD

[The Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of Agricultural Experiment Station, Morgantown, W.Va.]

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Young Stock at Meal Time

West Virginia as a Poultry State

As a number of the poultry bulletins of this Station are now out of print it has seemed desirable to republish the salient features of these bulletins, together with such other advice gained from the experiments conducted at this Station as will be particularly helpful to the poultry keepers of the State. Also an effort has been made to point out some of the manifest advantages of West Virginia from the standpoint of the poultryman.

Poultry keeping can be engaged in successfully even under unfavorable conditions, but for the greatest success the various factors of climate, soil, nearness to good markets, and general freedom from serious diseases must each and all be such that fowls can be kept healthy and productive at a minimum expense and the products marketed to the best possible advantage.

West Virginia may well be termed the Poultryman's Paradise, for in respect to the natural conditions favorable to the industry little remains to be desired.

Climate and Topography of West Virginia.

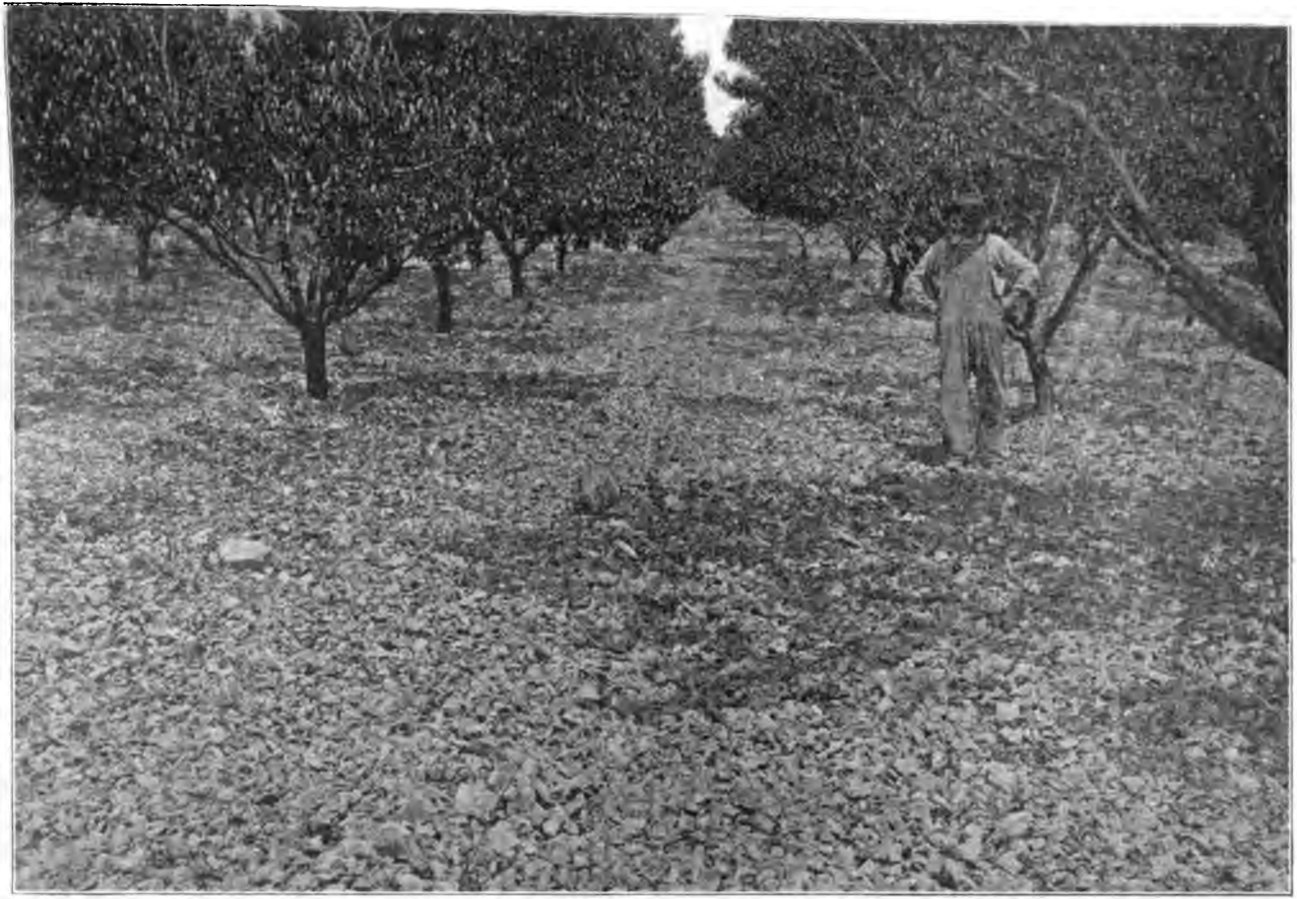
West Virginia is a region of hills and valleys and mountains, with countless coves so sheltered from storm and wind that fowls may enjoy free and unrestricted range practically every day in the year. In these sheltered locations, too, the grass begins to grow early in the spring and remains tender and green until late in the fall, and in connection with a mild and agreeable climate, this induces the fowls to live an outdoor life, with its consequent health, vigor and prolificacy. Fowls are more comfortable, more healthy and lay better when raised in a sheltered location protected from the wind.

The climate, too, of West Virginia is almost ideal for poultry, as the winters are neither so long and cold as further north nor the summers so hot and enervating as further south. The average annual mean temperature of the State is 52.3 degrees F. The mean temperature varies considerably in different sections, due to differences in altitude, which ranges from 280 feet above sea level at Harpers Ferry to a maximum of 4,860 feet, the height of Spruce Knob in Pendleton county. The actual range of latitude is 3½ degrees, from 37 degrees 10 minutes to 40 degrees 40 minutes, which gives a range of temperature of 3½ degrees, but the range of altitude being so great, from 280 to 4,860 feet, gives a range of temperature equal to a range of latitude of 10 or 15 degrees. In other words, the vegetation as well as the climate is such as may be found from the southern part of Virginia to Canada.

Soils.

The success or failure of any poultry enterprise depends to a large extent upon the character of the soil upon which the poultry plant is located, for if the soil is too heavy and tenacious there is a tendency for disease germs to accumulate to such an extent that after a time the fowls become unthrifty and unprofitable. Soil contamination with its consequent deleterious effects can be avoided to a certain extent by employing colony houses so that the fowls can be moved to a fresh piece of ground each year. Practically all of the upland soils of West Virginia are so well drained, however, that little trouble is experienced from soil contamination where ordinary methods of cleanliness are employed. Not only are the soils of West Virginia well adapted to poultry keeping in this respect, but land can still be purchased very cheaply even close to rapidly growing manufacturing towns and cities. The State, as a whole, is as yet somewhat sparsely populated.

Practically all soils adapted to fruit culture are adapted to poultry, for the reason that both require well drained soils. The production of fruit and poultry, too, may be made to go hand in hand, the trees furnishing shade so necessary for the comfort of the fowls during summer, and the poultry in return picking up many a noxious insect which might destroy valuable fruit, and gradually enriching the soil of the orchard by their droppings. The work of producing fruit and poultry can be so arranged that the slack period in the care and management of the flock will come when one is busiest with the fruit. Thus practically a double income may be obtained from the same area of land, each branch of the work helping the other.



Chert Soil Near Keyser, W. Va., Ideal for Fruit and Poultry.

Markets.

West Virginia is splendidly located in respect to markets. New York, the second largest city in size in the world, and the first city in the world in respect to the consumption of high-grade poultry products, is only 282 miles by rail from the extreme eastern portion of West Virginia, and Philadelphia, Baltimore and Washington are considerably nearer. Pittsburgh is less than 100 miles from the northern border, and Cincinnati, with its river transportation, is not so very much further from the southwestern portion of the State. All of these cities are near enough so that poultry products can be shipped by express and arrive in time to be sold and delivered to the consumer during the following day. Nearness to the great markets is a very important matter, especially in the case of poultry products, where freshness is one of the chief factors controlling the price.

For the small producer the home market, however, is the important one, and from that standpoint West Virginia is unexcelled, as the numerous mining and manufacturing towns that are springing up all over the State are increasing in population much faster than an increase is taking place in the production of poultry products. As a consequence of this condition a large part of the eggs and market poultry used in such cities as Clarksburg, Fairmont, Grafton, Morgantown, Elkins, Charleston and Parkersburg is shipped in from other states.

Poultry on the Farm.

The keeping of poultry is so widely scattered that we fail to gain a just conception of its real importance and magnitude.

The census of 1900 gave the value of the poultry products of the country for the year 1899 at $282,000,000, truly a vast sum. Five years later the value of the poultry products had practically doubled, amounting to $500,000,000. In 1907 there was a further increase of $100,000,000. That year the farm value of all corn produced in the United States was placed at $1,350,000,000, or not much more than double the value of the poultry products. Next in value to the corn crop stood the hay crop and cotton crop, each valued approximately at $650,000,000, only $50,000,000 in excess of the value of the poultry products. Wheat, for that year, was valued at $100,000,000 less than the value of the poultry products. But the end is not yet! In 1909 the value of the poultry products had advanced another $100,000,000, and it is confidently expected that for the current year of 1911 the value of the poultry products of this country will reach the astounding sum of one billion dollars.

Now there may be many who read these figures who will consider them wild and fantastic, thinking it impossible for the humble hen to create values of such magnitude, but let us view the matter from another standpoint. How much would it cost to supply to each person in New York City two eggs apiece, or enough for one meal? According to the last census, there are in New York City 4,750,000 people, or practically 5,000,000 at the present time. If each of these people were given two eggs apiece it would require 10,000,000 eggs. If we assume that the average wholesale price for fresh eggs in New York City is 24 cents per dozen, or 2 cents each, the 10,000,000 eggs would cost $200,000. Now if this calculation be made to cover a year's time, and if to the value of the eggs the value of the market poultry be added, we are led to see that in eggs and market poultry we have an agricultural product of enormous money value. In 1909 there were received in New York City 4,256,320 cases of eggs, each holding 30 dozen, or a total of 1,532,275,200 eggs. In round numbers these eggs were worth $25,000,000 on the farm, and cost the consumers from 40 to 60 per cent more.

About 89 per cent of all farmers raise chickens, and eggs may be said to be almost a universal food as well as one having a high nutritive value. The production of eggs is steadily growing, but the demand is growing faster than the supply, consequently the price of eggs is going up. In 1899 the farm price was 11.15 cents per dozen as an average for the United States, while in 1909 the average was 19.7 cents.

What is to be the future of this great industry? Are the poultry products to be produced on enormous poultry plants where fowls are kept by the tens of thousands, or are the farm flocks to produce the great bulk of the eggs and market poultry as at present? There is only one answer to this question. We shall continue to produce the bulk of the poultry products upon the farm, and for these reasons:

In the first place the principal item of expense in keeping fowls is for the feed. The farmer has cheap feed. The grain on the farm is cheaper than after transportation and commissions have been added to it. Therefore under all conditions and in all cases the farmer has the advantage of cheap feed. The farmer, too, has the decided advantage of cheap labor. The fowls on the farm are taken care of largely by the children, the boys and girls that are growing up on the farm, and so the farmer is not confronted with the labor problem. Then too, the farmer's fowls have free range. They pick up a considerable portion of their food from waste grain, from table-scraps, skim milk and from other things that otherwise would either go to waste or would not be utilized to such good advantage. And when the fowls are raised under free range conditions they have a tendency to be more vigorous and productive than where thousands of fowls are kept together, and where the soil frequently becomes impregnated with disease germs which so reduce the vitality of the fowls that they are no longer profitable.

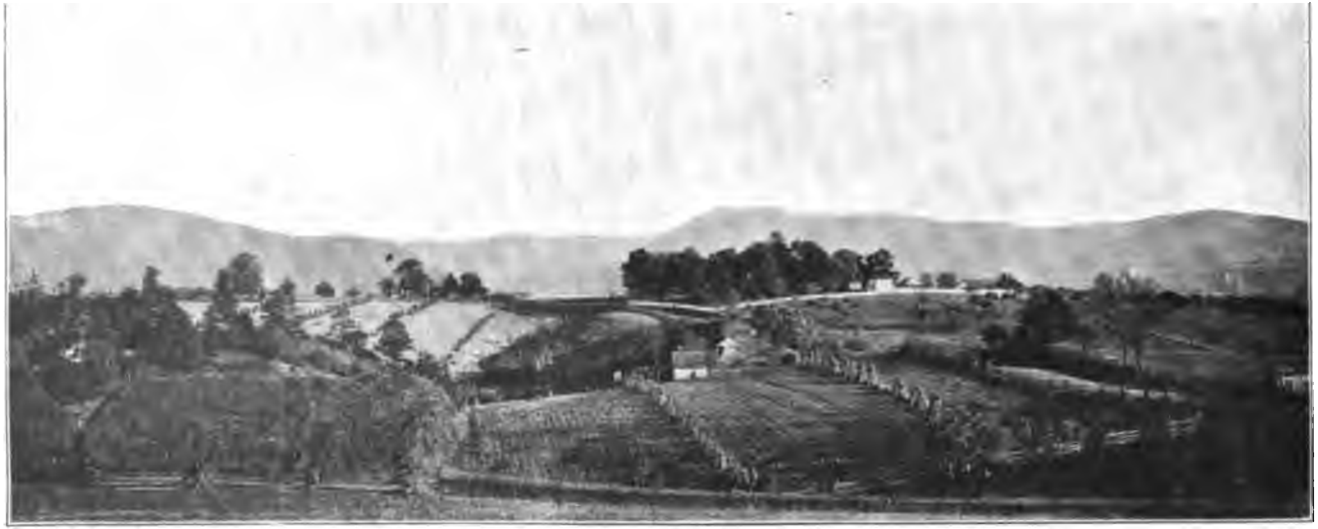
How to Make Farm Poultry More Profitable.

Now inasmuch as the farmer is to continue to be the primary poultry producer of the country, what should the farmers of West Virginia do to increase the profit which they should derive from their fowls?

Keep More Fowls.

In the first place the farmers of West Virginia should keep more fowls. According to the last census 89,293 farms, or 93.1 per cent of all farms in the State, reported fowls. The total number of fowls on farms is given at 3,310,155. This does not include the fowls in towns, villages, and cities which were not enumerated. About seven per cent then of our farms have no poultry of any kind, and the farm reporting poultry, have on an average, only 37 fowls per farm flock. This is entirely too small a number of fowls to keep on a farm. With better local markets and no better natural advantages Ohio has 68 fowls per farm, Pennsylvania 62 fowls per farm, and Maryland 63. We can double the number of fowls without materially adding to the cost of labor necessary to care for them, and without materially adding to the cost for the necessary buildings. In this way and at one bound we can double the net income from the poultry in the State. Fowls kept with a reasonable degree of intelligence should give a net profit after paying for the feed, labor, interest on the investment. etc., of $1 per head.. Now if we can double the number of fowls in our State we can increase the net revenue by something over $3,000,000, and we can do this next year if we would only get busy.

In this connection the following summary of poultry statistics for West Virginia from the Census Bureau is of interest:



Rolling Land with Sheltered Coves, Greenbrier County; W. Va., near Lewisburg.

Poultry Statistics.

The summary on poultry shows that the total number of farms reporting the different kinds in 1910 was 89,293, the total number of fowls being 3,310,155 and the total value $1,629,000.

Of the total number of farms reporting poultry, 89,293, nearly all, or 89,099, reported chickens, numbering 3,106,907, valued at $1,436,000; 18,762 reported turkeys, numbering 72,752, valued at $124,600; 10,447 reported geese numbering 72,972, valued at $43,800; 6,776 reported ducks, numbering 35,576, valued at $16,900; 3,486 reported guinea fowls, numbering 14,148, valued at $5,300; 941 reported pigeons, numbering 7,698, valued at $2,000, and 21 reported peafowls, numbering 102, valued at $235.

Of the whole number of farms in the State, those returning chickens formed 92.9 per cent; turkeys, 19.6 per cent; geese, 10.9 per cent; ducks, 7.1 per cent; guinea fowls, 3.6 per cent, and pigeons, 1 per cent. The reported increase in the value of poultry on West Virginia farms in the ten years, 1900 to 1910, was 69 per cent; the increase in total number of fowls 8.4 per cent. The number of farms reporting poultry increased 4,252, and the number of fowls per farm reporting increased from 35 to 37.

Comparative Summary. Poultry: 1910 and 1900.

	1910 (April 15)				1900 (June 1)
	Farms Reporting				
	Number	Per cent of all Farms	Number of Fowls	Value	Number of Fowls
Total	89,293	93.1	3,310.155	$1.628,700	3,053,071
Chickens	89,099	82.9	3,106,907	1,435,969	2,759,585
Turkeys	18,762	19.6	72,752	124,550	105,265
Ducks	6.776	7.1	35,576	16,854	58,273
Geese	10,447	10.9	72,972	43,802	129,948
Guinea fowls	3,486	3.6	14,148	5,325	(1)
Pigeons	941	1 0	7,698	1,965	(2)
Peafowls	21	(3)	102	235	(2)

(1) Included with chickens. (2) Not reported. (3) Less than one-tenth per cent.

Keep Younger Fowls.

Not only should the farmers of West Virginia keep more fowls, but they should keep younger fowls. On the farm, fowls of all ages run together. There is no system about keeping track of the age of the birds. When a chicken is caught for market or for the Sunday dinner, it is usually the first one that the farmer gets hold of. This is not the way to keep up a profitable farm flock. The younger the fowl, the more productive. The most profitable period in the history of a fowl is the first or pullet year, as one should get not only a high egg production, but also a considerable increase in live weight. In general an old hen is a poor layer. There should be some system by which a record of the age of the fowls can be kept. This can be done very easily, either by punching a hole in the web of the foot while the chick is still small, or by clipping off a toe when the chickens are removed from the nest or incubator. In carrying out the latter method the toe nail is cut off where it joins the toe, the shears being held in a slanting direction so as to remove the cartilege or root of the nail. If the toe nail is properly clipped off it marks the chick for life, and then the farmer when culling over his flock, just before they begin to moult in the fall, can select the oldest and leave the young and profitable ones.

Feed Better.

Another thing that the West Virginia farmer should do is to feed his fowls more intelligently. On the average farm, corn is the stand-by. On many farms corn is practically the only material that is used. That is entirely wrong. For the purpose of producing eggs, quite a large amount of nitrogenous material is required. The egg itself is a highly nitrogenous body, the white being almost pure albumen. Corn is too carbonaceous. It contains too much starch and oil. There is not enough protein present in it. Corn should be used as the foundation of the ration, but it should not be used to excess. Balance the ration with some nitrogenous feeding stuff. If skim milk can be had, there is nothing better. Let it sour, and either use it to moisten the ground feed or place it in pans and let the fowls help themselves. If skim milk is not available, it will pay to buy beef scrap. This consists of the odds and ends at the packing house. These are boiled and pressed so as to remove the excess of grease, then dried and ground. The scrap can be bought for about $3 per hundred pounds. The fowls can either be allowed free access to it or it can be mixed in the ground feed using about 10 per cent by weight.

Build Better Poultry Houses.

Not only should the farmers of West Virginia keep more and younger fowls and feed more intelligently; better houses should be provided. In this State it is not necessary to build expensive houses to keep out the cold, but the houses should be light, airy and dry in all kinds of weather, and the fowls should be free from draughts when on the perches at night. The houses should be kept clean and free from lice and mites. It is impossible to keep poultry profitably where lice and mites abound.

Keep Pure Bred Stock.

For best results, too, pure bred stock should be kept. The eggs from a mixed flock of fowls are of various colors and shapes, and the market fowls lack uniformity. Eggs to sell for the highest price in the big markets should be fresh, clean and of a uniform color and size. Only eggs from pure bred stock can possibly meet these requirements. The same principle is true in the case of market poultry. In the same way that a well bred steer is a more economical producer of beef than a scrub, so is a well bred fowl of the meat breeds a more economical producer of poultry flesh than a mongrel.

The Production and Sale of Market Eggs.

To start at the beginning, the hens should be provided with clean nests. A dirty egg is not only offensive in appearance, but as an egg shell is porous, the germs present in the filth gain access to the interior and the egg rots quickly. **Keep the eggs clean.**

The temperature at which an egg is kept influences the rate of decay. At summer temperature germs develop rapidly in egg substance, while at a low temperature the growth is very slow. In cold storage houses the temperature of the eggs is kept as close to the freezing point of the eggs as possible, so as to restrict germ development. **Keep the eggs cold.**

A fertile egg begins to develop into a chick even before it is laid, and this growth continues unless the egg is cooled below 68 degrees F. At 68 degrees F. the growth of the germ is barely perceptable, the germ soon dies and the egg rots, while at 103 degrees the growth of the chick is rapid. Hens lay as well when there is no cock kept with them. Hence sell all surplus cocks immediately after the breeding season. **Produce infertile eggs.**

An egg is never more valuable for eating purposes than the day it is laid. As time passes it gradually deteriorates

Well Drained Orchard Soil. Berkeley County, W. Va. Splendidly Adapted to Poultry.

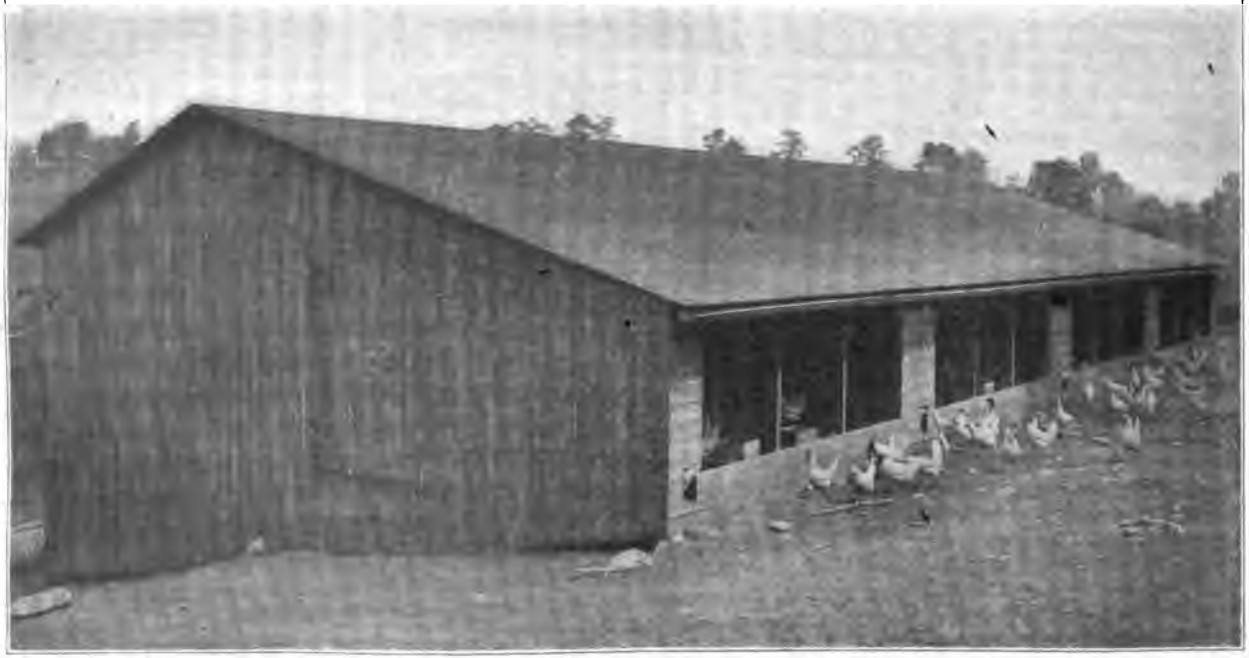
until finally it becomes rotten and worthless Statistics collected by the Department of Agriculture indicate that of the marketed eggs in the United States 7.8 per cent are rotten and a total loss, and a much larger percentage stale and comparatively worthless. This loss is due largely to the time elapsing before the egg is delivered to the consumer. **Deliver the eggs to the consumer promptly.**

Co-operative Marketing of Eggs.

Some of the advantages of the farm flock have been pointed out. What are the disadvantages as compared with the large poultry plant? It would seem that the principal disadvantage in the production of eggs or market poultry on the farm is in respect to marketing the products. A farmer with a few fowls cannot gain and cannot retain a first-class market for his eggs. Take for example a club or hotel. They require fresh eggs in October, November and December, just the same as they do in April, May and June. The farm flock is usually on a vacation in the fall and early winter unless early pullets are on hand to take up the work of egg production. Usually too, the farmer does not produce eggs enough so as to get in touch with a first-class line of trade. This matter of marketing, however, could be easily remedied. Let the farmers in one community get together and appoint one of their number a selling agent, whose duty is to grade, candle, pack and sell the eggs produced by the members of the little co-operative association. Let the eggs be brought together at least three times per week in the warm season, and at least once per week during winter. With this arrangement the eggs from five, six, or a dozen farmers can be sold to just as good advantage as the eggs of a poultryman who makes egg-production his specialty. In those sections where cheese factories or creameries are in operation the cheese-maker or butter-maker frequently acts as the selling agent and the system possesses such merit that it is being rapidly and widely adopted.

Egg Production.

For the average West Virginia farmer egg production is the most profitable branch of the poultry industry. A flock of hens kept upon a farm in a fairly intelligent manner should average to lay at least ten dozen eggs per hen per year. These are worth at least 20 cents per dozen or $2. The chief expense in keeping fowls is for the feed. This seldom, if ever, should cost more than $1 per hen per year, and if the farmer produces the feed it should cost considerable less. There remains then



Open-Front Laying House. Front View. Built on the "Continuous House" Plan.

in excess of the cost for feed $1 per hen per year, which is practically clear profit. What other branch of agriculture can a West Virginia farmer engage in that will yield approximately 100 per cent per year on the money invested? There are certain things, however, that must be kept in mind and practiced before a profit of $1 or more per hen per year can be obtained.

Good Layers.

The advice is generally given to select an egg breed for egg production, but on the average farm this advice cannot be carried out very well, as the principal egg breeds, Leghorns and Minorcas, are poor mothers and can scarcely be kept to good advantage unless incubators and brooders are employed in raising the chickens. Consequently a majority of farmers are forced to keep a general purpose breed. Of these the Barred Plymoth Rock, the Wyandottes, the Rhode Island Reds and the Orpingtons are all deservedly popular.

Far too many flocks of mixed fowls or mongrels are kept. These are less profitable than the pure breeds on account of the greater uniformity of the eggs and market poultry produced by the pure bred fowls. Eggs uniform in color and size are worth 2 or 3 cents more per dozen in the big markets than the white and brown eggs mixed indiscriminately together. This premium paid for uniformity is in itself a good profit. The same principle holds true when market poultry is disposed of in any considerable quantity. Then, too, a farmer with a good flock of pure bred fowls can almost always sell some eggs for hatching at a considerable increase over the ordinary market price for eggs for eating purposes, and in the fall many of the surplus cockerels can be sold to good advantage for breeders.

Natural vs. Artificial Methods of Incubation and Brooding.

Where fowls are kept in large numbers, incubators and brooders are a necessity, but where a farmer keeps only 100 or 200 fowls it is a very debatable question whether it will pay to procure the equipment necessary to raise the chickens by artificial means. As a general proposition hen raised chicks are more vigorous than those raised artificially. This is particularly true when the incubators and brooders are operated by beginners or by farmers whose others duties prevent the proper amount of attention being given to this work.

For raising chickens on a farm, the methods used by Mr. Almy, of Triverton Four Corners, Rhode Island, are well adapted. All hatching and brooding is done by hens, as the hens know better than the average farmer how to bring up chickens. Several hens are set at the same time, and when the hatch comes off, the chicks are distributed so that each hen receives a certain number. This number depends to a certain extent upon the season of the year, the later in the spring the more chicks a hen can care for. The hen with the chickens is then placed in a little coop about three feet square in which the hen remains until the chicks are old enough to wean. The front of the coop consists of a window sash containing six panes of glass usually about 10x12 inches in size. The sash can be moved so as to allow the chicks to run out of the coop and the opening can be adjusted easily to the chickens as they grow larger. The glass in the front of the little coop keeps the interior well lighted and prevents the development of disease germs during the somewhat long confinement of the mother hen. These little coops are placed in rows in a field so that the chickens may be fed and cared for easily. The chickens are raised on the same ground in succession only two years, at the longest, as the field where the chicks have been raised is then plowed and planted to corn and the little coops taken elsewhere. The raising of the chickens on fresh ground so as to prevent infection from intestinal parasites of various kinds is one of the very important features of this method, and when to that is added the raising of the chicks by natural means so that the eggs during incubation are never overheated or chilled, or the little chicks injured by improper methods of brooding one can easily understand how it is that Mr. Almy has been able to continue in the poultry business on a somewhat large scale for several years with a general increase in the strength, vigor and productivity of his flock. For the professional poultryman incubators and brooders are a necessity, but there are many farmers who could imitate Mr. Almy's methods to good advantage. Take the money that would necessarily be spent for incubators and brooders, if artificial methods were used, and fix up a good place for the broody hens so that they can be kept separate and apart from the laying flock, and then give the hen and her chickens as much time and attention as would necessarily be given to the incubator and brooders, and in most cases when fall comes and it is time to place the pullets in winter quarters there will be more of them and they will be larger and healthier than though artificial methods were used. There is no royal road to wealth in the poultry business. Care and attention and intelligence are as necessary now as ever, and unless incubators and brooders are properly handled their purchase will prove to be an unprofitable investment for the farmer.

Poultry Buildings.

The hen that lays is the hen that pays, and a hen lays best when provided with a suitable house properly located. What is a good type of laying house for the West Virginia farmer? In my judgment the open front house in some form or other and modified to meet individual requirements and conditions is most likely to meet the conditions of cheapness, durability and efficiency.

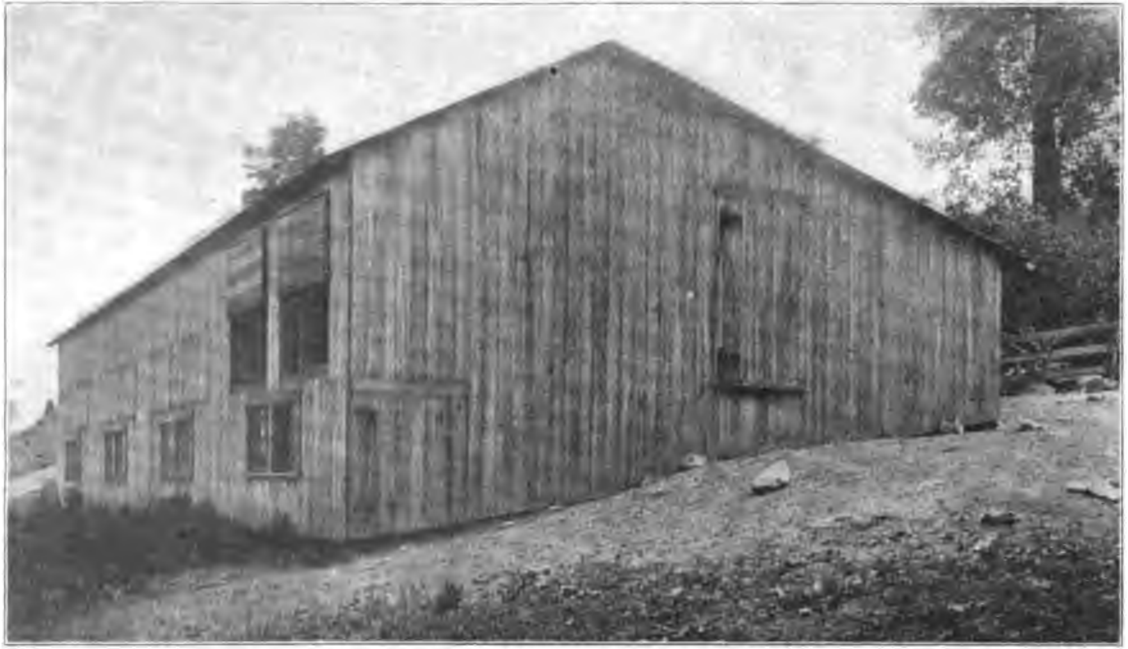
The open front house is characterized by having one end entirely open, or covered with wire netting so as to keep out stray animals. As usually constructed this house is 24 feet deep and 16 feet wide, and is 5 feet high in front and 6 feet in the rear. The roof is of unequal span, the peak being located two-thirds of the distance from the front to the rear, and having an elevation above the floor of 10½ feet.

The perches are on a level with the front opening. In winter when the fowls have gone to roost the warm air resulting from their presence tends to collect in the upper portion of the house maintaining a comfortable temperature even in severe weather. Last winter with its zero temperatures the combs of S. C. White Leghorn hens were not frozen even when the front of the house remained constantly open. In poultry houses having a shed roof the warm air constantly flows away from the fowls, when they are on the perches, thus making the shed roof type of house somewhat colder for the fowls at night.

In order to keep the house cool during the warm season two doors are provided in the rear wall of each section of the building, opening underneath the nest boxes. When these doors are open, as in summer, the wind has unobstructed passage through the house and the fowls when on the perches remain comfortable even on very sultry nights.

This house has been in use for two years and seems to be well adapted to West Virginia conditions. It should face the south or southeast, and if a wind break is provided opposite the open side so much the better.

One of the advantages of this house is that the fowls always have plenty of fresh air and consequently remain healthier than where they are compelled to breathe impure air too often found in poultry houses. The free circulation of air, too, prevents any condensation of moisture on the walls of the building during frosty weather, and the litter on the floor constantly remains crisp and dry. Fowls remain healthier in a cold dry house than in a warm damp one.



End and Rear View, Showing Two of the Ventilating Shutters Open. Open-Front House.

Feeding for Egg Production.

It should be understood at the outset that the food that laying hens receive is only one of the factors which may affect the production of eggs. We all know that fowls, in order to lay well, should be of the right age, neither too old nor yet too young; they should be kept neither too cold nor yet too hot; and that they should be healthy and free from lice and mites or other external or internal parasites. We know that some breeds lay better than others, and that some individuals and strains lay better than certain other individuals and strains of the same breed. We know that overcrowding, overfeeding on certain foods, too scanty feeding, lack of exercise, and unsanitary quarters have a tendency to decrease the egg production. We know that when fowls are frightened or frequently disturbed or placed amidst strange or unusual surroundings that the egg production is materially restricted; also that a lack of constitutional vigor tends to prevent a heaping up of the egg basket.

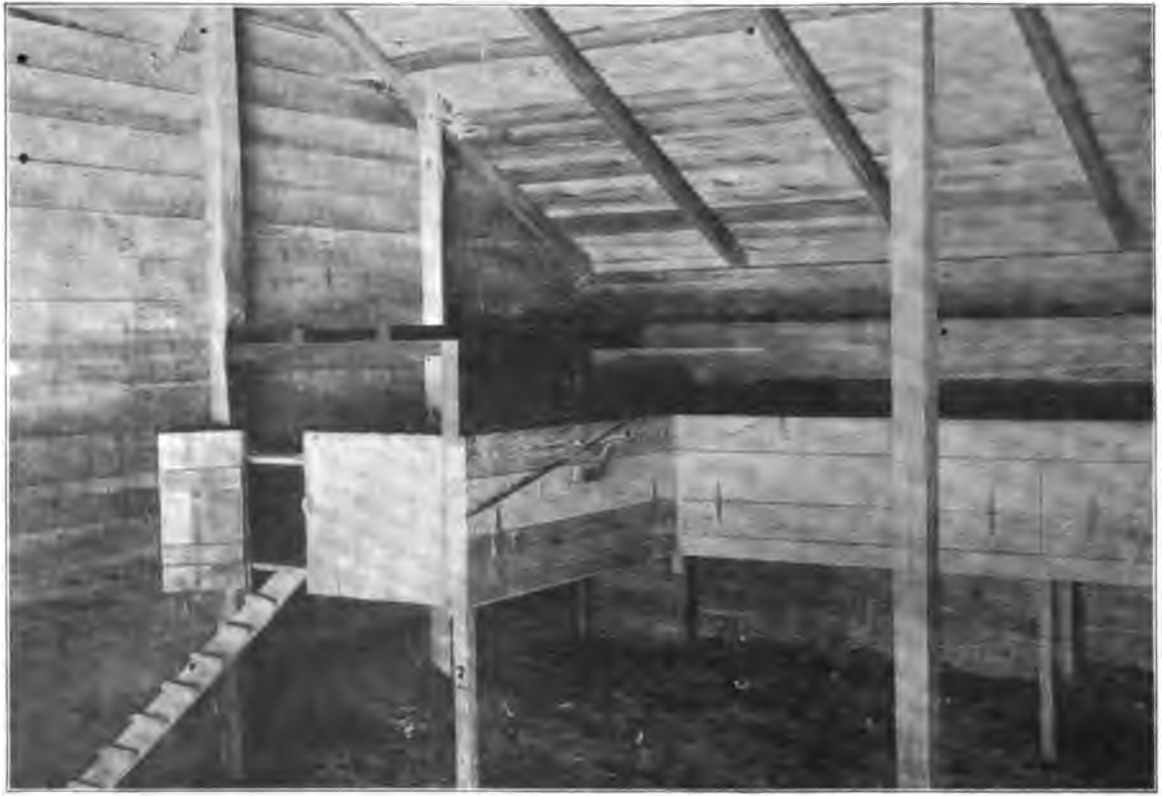
Sometimes it would seem that, relatively, too much attention is given to the subject of feeding and too little to the other factors which may have as great or even a greater effect upon the egg yield, but it must be admitted that the food that fowls receive is usually under definite control, while some of the other factors are matters of heredity, environment or the weather, which can be controlled only indirectly or not at all.

Egg production depends upon the activity of the ovaries, and this activity, in turn, at least to a large extent, depends upon the physical vigor of the individual. Heavy egg production, then, is principally a problem of how to maintain laying hens in a high state of health, and the question before us today is how to feed in order to accomplish this purpose, but it should not be forgotten that constitutional vigor is as much a matter of fresh air, exercise and inherited stamina as it is a matter of food.

A hen requires food in order to furnish energy to carry on the various activities of the body and to keep the body warm; to build up the tissues and organs and keep them in repair and to supply material from which eggs can be elaborated. For these various purposes different classes of nutrients are demanded, a brief discussion of which may be of interest.

Carbohydrates.

The heat and energy required by a fowl are derived mainly from the fat and a number of other carbonaceous materials in



Interior View of Open-Front House Showing Opening to Nest Boxes Underneath the Perches.

the food, termed carbohydrates, which include starch, sugar, cellulose and other materials of the same general nature. For most purposes it is desirable to consider the carbonaceous materials of a ration collectively, and as the fat has about two and one-fourth times as much heating value as an equal amount of carbohydrates, it is customary to multiply the amount of fat in the ration by two and one-fourth and add it to the other carbohydrates so as to arrive at the total amount of effective carbonaceous material in the ration.

Protein.

The organic part of the bones, the tendons, the internal organs and the muscles in the body of a hen are derived from the nitrogenous constituents of the food commonly termed protein. Wheat gluten and white of egg are examples of protein.

Ash.

A fowl would not develop or lay eggs, however, if supplied with protein, carbohydrates and fat. Ash constituents are required to give substance to the bones and to a certain extent to enter into the complex composition of the various organs, and in the case of the laying hen to form the shells of the eggs.

Three Classes of Nutrients.

In feeding laying hens, then, there are three classes of nutrients which we must keep in mind in order that the fowl may be nourished properly: protein to build up and keep in repair the various organs and muscular system of the fowl and furnish material for the formation particularly, of the white of the egg; carbohydrates and fat to furnish heat and energy and to supply a considerable amount of fat which enters into the composition of the yolk of the egg, and finally ash constituents for the formation of the bones, egg shells, and to enter more or less into the structure of all the various organs and tissues of the body. Nor should we neglect to mention water as more than one-half of the weight of the fowl, or an egg, consists of this material.

Composition of Fowl and Egg.

In this connection it is of interest to examine into the ralative proportion in which nitrogenous and carbonaceous matter enter into the composition of the body of a fowl, and into the composition of an egg, for a knowledge of this proportion gives us an insight into the reason why certain grains or by-products give poor results when fed alone or in certain combinations, but which give good results when mixed together or fed in certain other combinations. Now, according to analysis, the body of a hen contains, in round numbers, 55 per cent water, 3.8 per cent ash constituents, 21 per cent protein and 17 per cent fat, and a fresh egg contains 65 per cent water, 12 per cent ash, 11 per cent protein and 9 per cent fat. If we now multiply the percentage of fat in both instances by two and one-fourth so as to reduce the fat to the same thermal equivalent as a carbohydrate, and then divide the products thus obtained by the respective percentages of protein in the body of a hen and in an egg, we find, speaking generally, and in round numbers, that there is one part of protein to two parts of carbohydrates expressed as though present in the form of a carbohydrate, or in other words, the nutritive ratio of the body of a hen and of an egg is as 1 to 2.

If we now examine the composition of one of the grains commonly used in feeding poultry, namely corn, we find that instead of one part of protein to two parts of carbonaceous material, as in a fowl or in an egg, there is only one part of protein to ten parts of carbohydrates. Now, inasmuch as protein and carbonaceous materials enter into the composition of an egg in quite definite proportions it can be seen readily if a laying hen were fed wholly on corn there would be relatively too much carbonaceous material as compared with the protein, for the building up of the egg, this excess being about eight parts of carbonaceous materials for every part of protein changed into egg substance. It is true that some of this carbonaceous material would be used to keep the fowl warm and to furnish muscular energy, but there would be too much even for this purpose except during extremely cold weather, and this excess accumulating would in time make the fowl too fat, with a consequent loss of vigor. The outcome, then, would be, when feeding nothing but whole corn, that few eggs would be laid, because only a small amount of protein would be available for the formation of the eggs, and the excess of fatty matters would tend to clog the system, with a consequent reduction in the vigor of the fowl. It may be observed here properly that a hen must be moderately fat in order to lay. A ration consisting simply of corn would be deficient, too, in mineral matter, or ash, for the formation of the egg shell and for other purposes.

In order that the nutritive materials of the food can be used economically for the various purposes of the animal body it is customary to mix the feeding stuffs together in such a way that there is a just proportion or balance between the various nutrients. A ration thus compounded is said to be balanced, while a ration which contains a relatively large amount of carbonaceous materials is called a wide ration, and one which contains a relatively large amount of protein is called a narrow ration. The nutritive ratio of a ration is the proportion of digestible protein to digestible carbonaceous materials, and is found by multiplying the amount of fat by two and one-fourth, adding the product to the digestible carbohydrates and dividing the sum by the amount of digestible protein.

The following table, which will be valuable for reference, shows the composition and nutritive ratio of the more common materials used as poultry foods. The figures are taken principally from a table compiled by Professor Henry and published in a "Special Report on Diseases of Cattle and Cattle Feeding."

	Ash.	Crude Protein.	Carbohydrates.	Fat.	Nutritive Ratio.
Corn, Dent.	1.5	7.0	63.4	3.9	1:10.3
Wheat, winter	1.8	9.2	55.9	1.8	1: 6.5
Barley	2.4	9.5	66.1	1.2	1: 7.2
Oats	3.0	9.1	44.7	4.1	1: 5.9
Buckwheat	2.0	7.7	49.2	1.8	1: 6.9
Peas	2.6	18.0	56.0	.9	1: 3.2
Soy Bean	...	29.6	17.7	15.9	1: 1.8
Cowpea	...	18.1	34.5	1.3	1: 2.1
Cornmeal, bolted	...	6.3	61.8	3.0	1:11.0
Wheat bran	5.8	12.6	44.1	2.9	1: 4.0
Wheat middlings	3.8	12.2	47.2	2.9	1: 4.4
Oatmeal	...	11.3	49.9	5.8	1: 5.5
Brewer's grains dried	...	16.2	35.5	5.3	1: 2.9
Gluten meal	.8	25.0	49.4	5.6	1: 2.5
Linseed meal	5.3	27.2	31.8	2.7	1: 1.4
Dried blood	4.7	59.1	....	2.3	1: 0.1
Meat scraps	4.1	68.4	.3	13.5	1: 0.4
Skimmed milk	...	2.9	5.2	.3	1: 2.0
Red clover hay	6.2	6.5	34.9	1.6	1: 5.9
Mangels	...	1.1	4.8	....	1: 4.4
Entire egg	12.2	11.4	....	8.9	1: 1.8
Rutabagas	...	.9	7.1	....	1: 8.9
Hen, entire fowl	3.8	21.6	....	17.0	1: 1.7
Pullet, entire fowl	3.4	21.2	....	18.0	1: 1.9

As compared with the composition of an egg, most of the grains commonly employed as poultry foods are too low in protein and ash, and care should be taken to supply these deficiencies by the use of beef scrap, ground fresh meat and bone or other materials of somewhat similar composition. Feeding stuffs which are rich in protein usually cost more than those rich in carbohydrates and fat, and if there is a lack of the latter constituents some of the protein may be used to furnish heat and energy, instead of carbohydrates. This would be expensive, to say nothing about the effect upon the health of the fowls of feeding a ration that is too narrow. There should be a just balance or proportion between these classes of compounds for best results, but our knowledge of the feeding of poultry is not thorough enough so that definite and exact advice can be given as to the relative proportion in which these classes of nutrients should be present for best results.

Wide and Narrow Rations.

Professor William P. Brooks, of the Massachusetts Experiment Station, has been studying this subject for a long time, and has carried out some thirty-six experiments in feeding wide and narrow rations. The nutritive ratios of the narrow rations have averaged in these experiments 1 to 4.4, or, in other words, they averaged about as nitrogenous as wheat middlings. On the other hand the wide rations had nutritive ratios averaging 1 to 5.97, which is about the same as the nutritive ratio of oats, which are somewhat more nitrogenous than wheat. In these experiments conclusive results were not obtained, as about one-half of the tests favored the wider rations and the other tests gave results in favor of the narrower rations, and it seems probable from the evident care with which these experiments have been carried out, and the results which were obtained, that the nutritive ratio of the ideally perfect ration is not far removed from the average of the nutritive ratios of the rations employed, or about one part of digestible protein to five or five and one-half parts of digestible carbohydrates. It is not believed, however, that the proportion between these two classes of nutrients should be fixed and definite for all cases and conditions, as it stands to reason that a pullet not fully grown should be fed on a ration somewhat richer in protein and ash than required by an old hen, and that fowls during very cold weather should receive a ration more carbonaceous than during warm weather.

Importance of Ash Constituents.

In feeding for egg production it is necessary not only to have the proportion of protein to carbohydrates approximately correct, but it is also essential to have the ash constituents of the ration sufficient in amount. There is nearly eight times as much ash in the dry substance of an egg as there is in corn or wheat, and this deficiency must be made good in some way. Wheat bran, oil meal, beef scrap and clover or alfalfa hay are all high in ash and can be used with profit in a ration for laying hens, and in most cases these feeding stuffs high in ash should be supplemented by the use of cracked oyster shells, limestone grit or granulated bone fed ad libitum.

Animal Versus Vegetable Protein.

Most of the earlier experiments performed to study the relative value of protein from animal and vegetable sources seemed to show that the protein of animal origin is more valuable than vegetable protein for growth and egg production, but it has been found that the apparent superiority of animal protein is due largely, if not entirely, to the fact that it is usually associated with a larger percentage of ash in the ration. As soon as the difference in ash content is overcome then protein from the two sources seems to have practically the same value. Professor Wheeler, of the Geneva Station, in speaking of his investigation says: "The experiments all point in one direction: toward the superiority of rations containing animal food over those made up of grain. In no case has the reverse of this proven true, and in nearly all the trials the difference has been most noticeable. When the lack of mineral matter in all grain ration, as compared with one containing animal meal, is supplied by bone ash, the difference disappears or favors the grain ration, so far as chicks and laying hens are concerned. That is, it is the small amount of ash in the grain ration which makes this ration inferior to one containing animal meal, rather than a difference in the protein. Something to supplement the ash-poor grains they must have, and it is simpler to give it in the natural form, combined with valuable protein and fats, than to burn out the organic matter and give the ash only."

Whatever may be the explanation, then, the fact remains that beef scrap, meat meal, ground meat and bone, or similar products of animal origin are practically indispensable. Sour skim milk, too, is very valuable addition to a ration for laying hens whenever it is available.

The Importance of Green Food.

In some experiments carried on at the West Virginia Station several years ago it was found that a liberal, as compared with a scanty supply of green food, increased the egg production by two dozen eggs per hen per year. For use in winter mangels or large stock beets are one of the most popular of green food materials, on account of their feeding value, and ease with which they may be grown. Cabbage is sometimes used, and clover or alfalfa hay are excellent substitutes. The hay may be cut into short lengths, steamed and fed in the

Rolling Land near Morgantown. Here the Conditions Necessary for Health and Vigor In Poultry Cannot be Excelled.

mash, or the material may be fed in the dry state, as the hens quickly learn to pick off the leaves, heads and more tender portions. Because hens readily eat the leaves and heads of clover and alfalfa hay is not a good reason for assuming, however, that foods rich in fibre are especially valuable for poultry. On the contrary, experiments indicate that of two rations otherwise equal the one lower in fiber is the better. In fact oats, barley and buckwheat, all of which are relatively rich in fiber, usually occupy a secondary place in poultry feeding.

Dry Mash As Compared With Moistened Mash.

The dry mash system of feeding consists, as it is well known, of keeping a mixture of dry ground grain in feed hoppers so as to be accessible to the fowls. The whole grain that is fed is usually scattered in the litter, so as to induce the fowls to take a certain amount of exercise. At the Maine Station, where this system of feeding has been carried out with success for several years, the practice is to scatter four quarts of corn per hundred fowls in the litter early in the morning; at 10 o'clock they are fed in the same way two quarts of wheat and two quarts of oats. This is all the regular feeding that is done. The dry meal mixture that is constantly available to the fowls is composed of 200 pounds wheat bran and 100 pounds each of cornmeal, middlings, gluten meal, or brewers' grains, linseed meal and beef scrap.

Experimental evidence is lacking to enable one to say whether this system of feeding hens is as good or better than the old system of feeding a moistened mash. That the old system of feeding, although it takes more time and requires somewhat more judgment on the part of the feeder, is a very satisfactory method to follow cannot be questioned.

I have before me the report of the egg-laying competition of 1907-08, held at the Agricultural College, Roseworthy, South Australia. In this competition seventy-five pens of fowls were entered. Each pen consisted of six females and one male. They were fed as follows: At 7 a. m. they received a mash of bran and pollard (middlings), one and one-half parts of pollard to one part of bran, mixed during the cold weather with soup to which cut vegetables and green stuff was added, together with a handful of salt. The mixture was fed hot, and in a crumbly condition. The quantity fed to each pen varied according to the appetite of the occupants. At noon green food was supplied during the cold weather, but when the warm weather set in this was withheld, as it soon dried up in the heat. Chaffed alfalfa, during the hot period, was mixed with the mash in the proportion of one-third by bulk. At 4:30 p. m. grain was fed to the birds in straw litter. During the winter maize and peas were used, but the principal grain was wheat. The grain in the scratching litter provided constant exercise and occupation for the birds. No green cut bone, spices, or other forcing foods were used, and the diet was well balanced, though simple in character. During the year there were consumed 331 bushels of wheat, 537 bushels of pollard or middlings, 430 bushels of bran, 950 bushels of meat meal. The amount of corn and peas fed is not given, but the amount fed was relatively small judging from the cost of these materials.

When fed in this way the banner pen, White Leghorns, laid during the year 1,531 eggs, or an average of 255 eggs per bird. The next highest pen, also White Leghorns, averaged 254 eggs per bird. Of the seventy-five competing pens thirty-four were White Leghorns, and it is of interest to observe, in respect to the influence of strain upon prolificacy, that, although the two foremost pens of White Leghorns led all of the other breeds by a considerable margin, yet there was a pen of White Leghorns in the sixty-eighth place with a record of only 141 eggs per fowl.

It is very doubtful whether an average of 255 eggs per bird in a pen containing six females could have been made through the use of the hopper system of feeding. I understand that our Department of Agriculture at Washington is making a study of this matter, and it is probable that at our next meeting we may have some definite information about this important subject.

In conclusion let me call your attention to the fact that the feeding of laying hens is a problem of a different nature than the fattening, for example, of a bunch of steers. In one case the food is digested, assimilated, and used to build up the bodily structures, and the principal things required are good feeding stuffs and a good digestive system. In the case of laying hens, however, not only must the digestive system be able to digest a large amount of relatively rich food, but the reproductive organs must be kept vigorously active, and in a most perfect condition, and this ideally perfect condition is not entirely a matter of food or methods of feeding.

In the early history of our country large families were the rule. Our ancestors were healthy, vigorous and good breeders. They were of necessity active men and women, for they had a continent to subdue with Indians, forests and wild beasts. It does not seem probable that their food was any more wholesome than that which we have today, but their families were larger, and it is my belief that herein lies an important principle which we should constantly keep in mind when dealing with poultry.

Raising Chickens Artificially.

Although it is believed that most farmers who raise from one hundred to two hundred chickens annually will do well to continue to raise hen-hatched chicks instead of purchasing and using incubators and brooders, yet as there is a wide-spread demand for information regarding the best methods of raising chickens artificially, the following discussion of the subject has been included in this bulletin. To a considerable extent this discussion is a reprint of bulletin 98, although certain portions have been rewritten so as to be in conformity with later experiments.

Although chicks have been raised by artificial means in Egypt, China and perhaps other warm countries almost from time immemorial, yet, in the temperate zones where the climate is not so favorable for this purpose, artificial incubation and brooding is practically a recent development. On account of this fact the art of raising chickens artificially has not been perfected so fully as is the case with most other branches of husbandry which have been engaged in for a much longer time.

During the past ten or twelve years from one thousand to three thousand chickens have been raised annually at this Station by artificial means and various experiments connected with this work have been performed. In this discussion it is planned to give, not so much the details of experiments, but rather the practical results as the outcome of all of them.

The Production of Eggs Suitable for Hatching.

In order to raise chickens successfully it is very essential to begin with eggs which will hatch well and produce strong vigorous chicks. If the germs are naturally weak no amount of attention and good care during the incubation of the eggs and the brooding of the chicks will make up for the original lack of vigor. In spite of all that can be done the hatch will be poor, and many of the chicks which do hatch will die. As one cannot determine by an examination of the unincubated egg whether the germ is strong or weak the only thing that can be done in practice is to select the breeding stock with such care and give it such attention that eggs suitable for hatching must of a necessity result.

Age of Breeding Stock.

Early hatched pullets lay better in winter, when eggs are high in price, than old hens, and as a consequence on many egg farms practically all of the older hens are disposed of each summer and their place is taken by pullets hatched during the preceding spring. While this undoubtedly is good policy from the standpoint of winter egg production, yet it has led in many cases into the practice of incubating the eggs of these pullets, during the following spring, when the fowls are practically one year old. Is it a good plan to use such eggs for hatching? Are the resulting chicks strong and hearty, and do they develop into as thrifty, vigorous individuals as though they were the offspring of more mature stock?

To throw light on this question eight experiments were carried out and the following summary gives the results of these tests:

	Old Hens.	Pullets.
Total number of eggs incubated less those cracked in turning	1094	871
Average weight of eggs per hundred	12.96 lbs.	11.19 lbs.
Total number of chicks	840	591
Per cent. hatched of eggs incubated	76.7	67.8
Average weight of chicks per hundred when removed from incubator	8.28 lbs.	7.12 lbs.
Average weight of chicks at second weighing, per hundred	29.56 lbs.	23.07 lbs.
Total number of recorded deaths	42	85
Per cent. of chicks which died	5	14.5

The results of this series of experiments clearly show that it is a matter of prime importance to have the breeding stock vigorous and of mature age. The eggs from the young fowls were smaller than the eggs from the older hens, and the chicks were smaller when they were hatched, grew more slowly, and more of them died from chick diseases than was the case with chicks hatched from eggs laid by the mature fowls.

Feeding Breeding Stock.

The fowls should be fed a ration containing in proper proportion the different food elements required. Green food, grit, pure water, pure air, and the opportunity to take exercise are all important. Whenever possible the breeding stock should be allowed unrestricted range, as this induces them to take plenty of exercise which tends to keep them healthy, and they are also able, to a certain extent, to balance their own rations by means of the bugs and worms which they secure.

In feeding it is important to feed neither too much nor too little, for one extreme is as bad as the other. If fed too much the fowls are apt to become sluggish and lazy, and the chickens which result will almost invariably be weak. On the other hand if the fowls are fed too scantily a large proportion of the eggs will be unfertile, and the chicks will not be as vigorous as they otherwise would. The fowls should be well fed but not overfed on a ration containing enough protein. This may be supplied by beef scrap, ground fresh meat and bone, skim milk, or some other substance of similar nature. With the small active breeds of fowls like the Leghorns mash may be fed with safety once per day, but with the meat breeds which have a tendency to become too fat it is usually best to feed mostly whole grain scattered in litter. The method of feeding Leghorns for the production of eggs suitable for hatching which has been adopted at this Station is as follows: In the morning whole grain consisting of equal parts by weight of corn, wheat and oats is scattered in the litter covering the floors of the poultry houses. This is fed at the rate of from 7 to 10 quarts per hundred fowls. In the evening mash is fed consisting of equal parts of corn meal, ground oats and wheat middlings to which is added ten per cent of beef scrap or meat meal. The mixture is moistened with skim milk or water, and fed at the rate of from 6 to 8 quarts per hundred fowls. If this is eaten up quickly and the fowls appear hungry more whole grain is scattered in the litter. Under this system of feeding and allowing one vigorous cock to ten or fifteen hens the eggs have uniformly run high in fertility, and the chicks have been strong and hearty. *It is a very bad plan to use eggs for incubation which have been produced by hens that have been fed heavily during the winter for egg production. Under these conditions the vigor of the hens, when spring comes, is apt to be reduced, and even though the eggs may hatch fairly well the chicks are apt to be weak and puny. The breeding stock must be vigorous in order to produce the right sort of eggs.*

Artificial Incubation.

The success or failure of artificial incubation depends largely upon the machine selected to do the work. Therefore great care should be exercised in making the selection. To be satisfactory a machine must be durable. There are many machines on the market which will hatch well when new but which are constructed so flimsily that in a short time they become worthless, and in this connection it should be remembered that an incubator which fails to give good hatches is worse than useless as each time that it is operated unsuccessfully the eggs are lost, the oil used is wasted, and the opportunity to make a profit from the chickens which should have been hatched is gone forever. Therefore, if artificial incubation is practiced it is wise to have good machines with which to do the work. Personally I am in favor of hot air machines because there is no water to bother with, no tanks to rust out and leak, or freeze and burst in cold weather when not in use.

The Location of the Incubator.

Although the modern incubator can be operated almost anywhere, yet to be most successful it should be located where the temperature is as uniform as possible. The advice has frequently been given to locate the incubator in the cellar. This advice is all right provided the cellar is clean, light and well ventilated. A close, dark, ill-smelling cellar is about the worst place imaginable for this purpose. A half-cellar, four feet in the ground and three feet above, is an ideal place in which to run an incubator. Such an arrangement admits of enough air and light, and affords a temperature uniform enough for all practical purposes. In operating an incubator in a dwelling house it is well to remember that many insurance policies do not provide for risks of this nature, although in reality there is scarcely any danger from fire if the incubator is given reasonable attention.

The Operation of the Incubator.

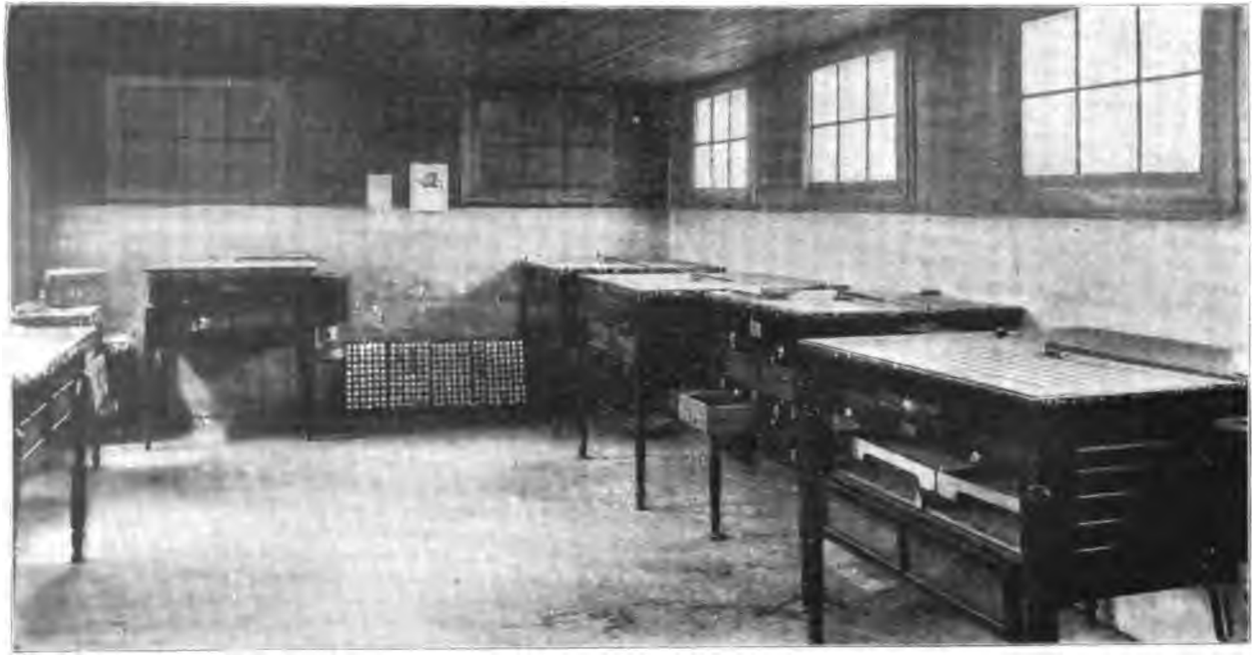
The machine should be set up carefully according to directions and the incubating chamber gradually brought to the proper temperature. The temperature which the thermometer should register depends somewhat upon its position in the incubating chamber. If the thermometer merely records the air temperature on a level with the tops of the eggs as they lay upon the trays, and is suspended near the center of the chamber then a temperature of 102½ will bring the chicks out promptly on the twenty-first day. The eggs should not be placed in the incubator until after the operator is able to maintain a fairly uniform temperature. Unless the regulator is properly adjusted to the right temperature and all the parts in good working order it is a very easy matter for the temperature to run too high and thus injure or totally destroy the hatch. The temperature should be maintained as uniform as possible. All violent fluctuations are unnatural and injurious. This is especially true of temperatures above the proper incubating temperature. Cooling the eggs a few degrees below the proper incubating temperature does no harm and in case the ventilation of the machine is not sufficient to supply the germs with enough oxygen this cooling may be necessary for a good hatch.

Ventilation and Moisture.

The ventilation of the machine is next in importance to the temperature. During their development the germs absorb oxygen and throw off carbon dioxide or carbonic acid gas as it is sometimes called. If the carbon dioxide is allowed to accumulate, or in other words, if the vitiated air is not replaced by pure air with sufficient rapidity, the germs will be weakened and those which are somewhat naturally weak will be killed. It is my impression that bowel trouble, and non-absorption of the contents of the yolk sack, two very common ailments of incubator chicks, are frequently caused by lack of fresh air in the incubating chamber during the hatch. For good results the eggs must be given plenty of fresh air. When this is overdone another trouble is encountered. The eggs lose too much moisture and the chicks dry fast to the shell, thus destroying many chicks and producing many cripples. On the other hand if the eggs do not lose enough moisture the chicks are weak and flabby and do not have sufficient room so that they are able to break their shells and thus make their escape. Between the two extremes of too much moisture and too little there is a medium where the moisture conditions are just right, and which when closely adhered to in practice gives best results. In bulletin No. 73 the loss in weight of eggs while being hatched by hens is discussed, and I quote as follows from that publication, which is now out of print:

"It is unnecessary to describe in detail the stages in the development of a chick. The chick, however, absorbs oxygen, and moisture and certain gases are thrown off through the shell. Under normal conditions the total amount of moisture and gases which have been thrown off at any particular time corresponds to that particular stage in the development of the chick, or in other words, when the egg is incubated under perfectly normal conditions the total loss in the weight of the egg corresponds, within certain limits, to the stage of development of the embryo."

"If the operator of an incubator knows how much a certain number of eggs have lost in weight since the beginning of the incubating period and compares this loss with the normal loss of the same number of eggs for the same length of



The Incubator Cellar.

time when incubated under hens, he will know definitely whether the eggs have decreased properly in weight. If they have lost too much, provided of course, that the temperature has been normal, they are drying up too rapidly, and either more moisture should be supplied, or the amount of ventilation should be reduced, but in reducing the circulation of air through the incubating chamber it must be remembered that pure air surrounding the eggs is just as important as a proper temperature; on the other hand, if the eggs are not losing weight as rapidly as they should they are either kept too moist, or they are not receiving the proper amount of ventilation, or perhaps they may be kept too moist and insufficiently ventilated also."

"The object of this bulletin is to furnish sufficient data to enable the operators of incubators to exercise a more intelligent supervision over the operation of their machines. A number of experiments have been performed to determine the normal loss in weight of eggs during incubation, and for this purpose the natural method of hatching has been employed. Eggs have been weighed, placed under broody hens in locations suitable for a perfect hatch, re-weighed on a chemical balance at suitable intervals, and the loss determined."

As a result of the studies detailed in bulletin No. 73, the following directions were issued covering the practical points involved:

Directions.

After placing the eggs upon the trays ready for the incubator set the trays upon a pair of scales reading to ounces and note the total weight of the eggs and trays. (The trays should be thoroughly dry). After a few days weigh again. Subtract this from the first weight. This will give the actual loss in weight of the eggs.

Example.—Suppose that you have 208 eggs on the trays; that the first weight with trays is 24 pounds 2 ounces; and that on the sixth day the weight is 23 pounds 6 ounces. Then the loss in weight is 12 ounces. Now look in the table for the loss in weight of 100 eggs for six days. This is 10 ounces. Ten ounces multiplied by 2.08 gives 20.8 ounces, which is the calculated loss for 208 eggs for six days. Therefore the eggs have not been losing weight as rapidly as they should, and the eggs should be given more ventilation or the incubator should be removed to a drier location. (It is assumed that the eggs are kept uniformly at the proper temperature). After the eggs have been tested for the infertile ones weigh again and proceed as before.

Rules.

If the eggs have *lost too much weight* give more moisture or less ventilation, but in reducing ventilation great care should be used, as pure air in the egg chamber is absolutely necessary.

If the eggs have *not lost enough weight* open the ventilators, or place the incubator in a drier place.

Table showing normal loss in weight of 100 eggs in ounces for the first nineteen days of incubation:

1...... 1.65
2...... 3.31
3...... 4.96
4...... 6.62
5...... 8.28
6......10.00
7......11.72
8......13.44
9......15.16
10......16.88
11......18.60
12......20.33
13......22.10
14......23.88
15......25.66
16......27.44
17......29.21
18......30.99
19......32.77

Turning.

The eggs should be turned twice per day until the nineteenth day of the hatch. It is not necessary to turn each egg just half way over each time. This is unnatural and I think, to a certain extent injurious, and it is probably partially due to this fact that the extra-tray method of turning seldom gives as good satisfaction as hand turning. In turning eggs by hand on trays built like the Cyphers the eggs at the center of the trays are picked up and other eggs rolled into their place. The eggs taken from the center are then placed at the ends. This method possesses the advantage of systematically changing the relative position of the eggs upon the trays, thus equalizing the effect of any possible inequalities of temperature which may exist in the incubating chamber. This principle of overcoming the effect of any variation in temperature is further carried out by changing the trays from side to side at one turning, and at the next turning change them from end to end, and so on. When these things are done the chickens nearly all hatch at about the same time. A hatch which is long drawn out usually indicates that there are inequalities in the temperature of the incubating chamber which have not been overcome by changing the eggs about as indicated above.

Airing and Cooling Eggs During Incubation.

Eggs hatched under natural conditions are left unprotected when the broody hen leaves the nest in search of food. At such times the eggs become cool or even cold, and being freely exposed to the air the absorption of oxygen and the excretion of carbon dioxide is facilitated. In the popular mind this process of cooling and airing is associated with the development of strong vigorous chicks, and consequently it is not surprising to find many incubator manufacturers giving directions in regard to cooling and airing eggs during the process of incubation. There is, however, a general lack of specific instructions or advice as to how long to cool the eggs or how cold to allow them to become.

In the case of natural incubation it would seem that the process of cooling and airing is due to the necessity of the mother hen of obtaining food, and may have no connection whatever with normal incubation. Instead of being of benefit, the cooling of eggs during incubation may be detrimental, inasmuch as cooling the eggs tends to slow down the vital processes and delays the development of the embryos.

In the case of machines in which the ventilation is imperfect it is quite possible that the cooling and airing process may be of benefit by giving the embryos fresh air rather than through the cooling effect, although it must me admitted that merely the cooling of the eggs may be the means of giving the embryos an increased supply of oxygen, for, when an egg is cooled the heated air in the air cell contracts and a small amount of air is drawn in through the pores of the shell.

To throw light on this question five experiments were carried out and the following conclusions were drawn as the result of the tests.

In the first trial with the ventilators open and with an average maximum and minimum outside temperature of 80° and 54.7°, respectively, a better hatch was obtained, and the chicks were stronger when the eggs were not cooled.

In the second trial with closed ventilators, and with a low external temperature, the eggs not cooled hatched better and the chicks were stronger than was the case with the other treatment.

In tests 3, 4 and 5, conducted simultaneously, with closed ventilators, and a high outside temperature, the eggs not cooled hatched better than the cooled eggs in the two Cyphers incubators and not quite so well in the Prairie State. The chicks, however, from the cooled eggs were materially stronger than the others in all three hatches, as fewer of them died. This would seem to indicate that in warm weather when the circulation of air in the incubator tends to become sluggish, and especially with an insufficient opening of the ventilators, it may be advisable to air the eggs for a reasonable length of time for the purpose of giving the embryos a more adequate supply of oxygen.

Near Morgantown, W. Va. Sheltered Coves Where Poultry is Protected From Wind and Storm.

It is difficult to conceive of any valid reason for cooling eggs during incubation and thus slowing down the vital processes, and these experiments seem to indicate that the beneficial effects which unquestionably sometimes result from the process of cooling and airing are due to the airing, and that the cooling of eggs during the process of incubation below the proper incubating temperature, when considered by itself, is detrimental,

Testing.

The unfertile eggs and those with dead germs are usually tested out twice during the hatch. This is done so as to keep the air in the incubator as pure as possible, and when these eggs are used for feeding young chickens the more promptly they are removed after their condition can be determined by the egg tester the better.

Now, having started with eggs suitable for hatching; having kept them at the proper temperature; having turned them regularly twice each day; having given them sufficient fresh air for the germs to develop properly; and having regulated the moisture conditions just right, allowing the eggs neither to dry down too much nor to retain too much moisture, the chicks on the nineteenth day should begin their efforts to divest themselves of their shells and on the twenty-first day the incubator should be full of downy bright-eyed chicks anxiously awaiting their liberation.

Taking Off the Hatch.

After the eggs begin to pip they should be interfered with as little as possible. The front door should not be opened to see how the hatch is progressing, as this reduces the humidity of the air in the incubator and also lets cold air strike the chicks not yet dried off, both of which things are injurious. Close watch should be kept of the thermometer at this time and if the temperature tends to drop, due to the drying off of a large number of chicks, the lamp should be turned up higher for a time, or the regulator slightly adjusted. On the other hand it is frequently necessary when the weather is warm to remove the lamp entirely during the latter part of the hatch, the heat generated by the chickens being sufficient to keep up the temperature.

After the chicks hatch they tend to crowd towards the light, and it sometimes happens that those in the front part of the incubator become so hot by being crowded together that they pant. Impure air, also, may cause them to pant. Whether caused by too much heat or by impure air the panting of the chicks is unnatural and injurious, and should be stopped either by opening the ventilators so as to give more air; by reducing the temperature; or by removing some of the chicks to the brooder so as to give those remaining more room.

From the time the chick pips the shell until it is transferred to the brooder and has become hardened and accustomed to its new surroundings is a very critical time in its history, and mistakes made at this time are almost irreparable. If a cold draft of air strikes the chicks which are not dried off; if they are exposed to the cold air while being transferred to the brooder; if the brooder is too cold for them; or if, after being placed in the brooder, they wander outside and become chilled before they learn where to go to get warm, they will catch cold, inflammation of the lungs will result in many instances, and the chicks will die. Or if the chicks become overheated in the incubator, or are allowed to pant on account of the lack of sufficient fresh air, they are seriously weakened, and many of them will die before they are ten days old from bowel trouble. In fact, to obtain the best results almost constant supervision should be exercised during this trying period of the chick's life.

Brooding.

Temperature. In brooding chicks either in individual brooders or in brooder houses the main thing which must be watched is the temperature, for if the temperature is either too high or too low the results will be totally unsatisfactory even though all of the other conditions governing the health of the chicks are ideal. Chicks three or four days old are fairly hardy little creatures and can endure a considerable degree of cold provided that as soon as they become too cold they can quickly get warm again. But if they are forced to remain where the temperature is too low they catch cold very quickly, the lungs soon become inflamed, little nodules of light colored cheesy matter form in them and death results.

The temperature of the brooder or brooder house when the chicks are first transferred from the incubator should be practically as high as the temperature of the incubator from which the chicks have just been removed, or from 95 degrees to 100 degrees F. This temperature should be maintained for the first week, never allowing it to fall below 95 degrees. The second week the temperature should not be allowed to drop lower than 90 degrees. These temperatures refer to the air temperature taken on a level with the chicks. After the second week the temperature should be reduced gradually until the chicks are old enough and hardy enough to do without artificial heat. At no time should the chicks be uncomfortable either on account of too much cold or too much heat. If they are too cold they will huddle together, those on the inside of the bunch will become too warm and will pass to the outside where they become too cold again. Under these conditions the chicks rapidly catch cold and die. On the other hand it is almost as bad to have the temperature too high, for in this case the vigor of the chicks will be reduced and they will be unprofitable. The heat should radiate from above down on the chickens' backs.

Where the chicks are to be raised on a large scale the brooder house heated by hot water pipes is the most economical, for in this case there is only one fire to attend, and the work of feeding and watering the chicks can be done much easier than when the chicks are scattered about in individual brooders. In fact, it has been my experience that outside brooders are not very satisfactory, for the work has to be done out of doors in all sorts of weather, making it disagreeable and costly to perform.

During the past year I have had some experience with the Petaluma system of brooding. According to this methed, no hovers are used. The chicks are placed on the floor of the brooder house surrounding the brooder stove which reflects heat down on their backs. From fifteen hundred to seventeen hundred chickens can be raised in one flock in this way. This method seems to be well adapted to raising chickens on a large scale, as the labor in caring for them is very materially reduced, and the chicks always have plenty of fresh air and grow up strong and vigorous.

Feeding. Next in importance to the temperature at which the little chicks are kept is the food which they receive. In the case of a chick, nature provides for its sustenance until it is able to run about and obtain food partly by its own efforts. The food material thus provided consists of the contents of the yolk sack which is slipped into the abdominal cavity a few hours before the chick is hatched. The yolk sack is connected with the intestine by a duct through which the semi-fluid mass passes into the digestive system where it is absorbed.

In feeding little chicks it should be clearly realized at the outset that they grow much more rapidly in respect to their original weight than any other of our common domesticated animals. Chicks when removed from the incubator weigh about one and one-half ounces each, and they can be made to weigh two and one-half pounds or forty ounces apiece when twelve weeks old. This is an increase of slightly more than twenty-six times the original weight in twelve weeks. In other words, during the first twelve weeks of its life a little

Col. R. M. Washington, a Well Known Poultryman of West Virginia. His Large Commercial Poultry Plant is Located Nearby.

chick averages to increase in weight each week more than double its original weight. Let us see what this means, taking for an example a young child. If a baby weighing ten pounds at birth were to grow relatively as fast as a chicken it would weigh about 260 pounds when twelve weeks of age! This extreme rapidity of growth in the case of a chicken requires liberal feeding, and I have never yet been able to understand why the advice is so frequently given not to overfeed little chickens, for if the chicks are healthy and are given an opportunity to take a normal amount of exercise they will not eat more than they can properly digest and assimilate. A baby under normal conditions doubles its original weight in about 180 days; a chick in about six days. In other words the processes of digestion and assimilation are about thirty times as active in the case of a chick as in a baby, and the amount of food required is about thirty times as great in proportion to the body weight Liberal feeding is the keynote of success in feeding little chicks. Feed them liberally from the start and keep them growing.

Before the chicks are removed from the incubator it is a good plan to cover the floor of the brooder with shreaded alfalfa or similar material to the depth of two or three inches. A good grade of chick feed should be added to this and the whole thoroughly mixed so that the pieces of grain are uniformly distributed throughout ,the mass. The chicks will soon begin to scratch in this litter, thus taking necessary exercise. Water should be provided from the start, and in addition to the chick feed in the litter, is is a good plan to feed a moistened mash once or twice a day. The mash may have the following composition: Equal parts of corn meal, wheat bran, and ground oats from which the coarser hulls have been removed and to which 10 or 15 per cent of good beef scrap has been added. If skim milk is available with which to moisten the mash it should be used, and in that event 10 per cent of beef scrap is sufficient. Only enough milk or water should be used to moisten the mash. It should not be sloppy. It should be fed only in such quantity that the chicks clean it up promptly, care being exercised to give the chicks sufficient trough room so that all may have an equal chance. After the chicks have become two or three weeks old cracked corn and wheat may be substituted gradually for the chick feed. When the chicks become old enough not to require artificial heat and are placed in colony houses and given free range it is a good plan to supply dry mash in hoppers and gradually cease from feeding the moistened mash. Milk is of great value in raising chicks as it supplies protein in a very digestible form and is rich in mineral elements.

I have also had excellent results in feeding little chicks according to the method advocated by the Maine Experiment Station. Briefly this method is as follows:

A mixture of three parts of corn meal, one part wheat bran, and one part wheat middlings or flour is used from which to make bread. This is mixed very stiff with skim milk or water and salted as usual for bread. It is baked in a slow oven, and when done the loaves are split open and returned to the oven where it remains until the bread is thoroughly dry. The crusts are then pounded until they are pulverized. The infertile eggs are hard boiled and ground shell and all in a sausage mill. One part ground egg and four parts bread crumbs are then mixed together and the mixture run through the sausage mill or food chopper.

The chicks are fed in the morning and at night on the bread and egg mixture, and during the middle of the day they scratch in the litter for the dry cracked grain or chick food which is provided for them. The egg mixture is used for about two weeks, and although it is expensive when infertile eggs are not available, yet it makes the chicks thrive wonderfully well. Grit and charcoal must be freely provided and after the chicks are a few days old green food in some form becomes a practical necessity. This is an excellent method, but is somewhat laborious when large numbers of chicks are raised.

Mineral Nutrients. In a preceding paragraph we have already seen that chicks grow relatively very rapidly. Now if we may judge by analogy the rapidity of growth and the demand for mineral nutrients are closely connected. It is true that we have little or no data available in regard to this matter with direct reference either to birds or the lower orders of organic life, but some very careful studies have been made with mammals, those animals which suckle their young, and it has been found that the more rapid the growth of the young the more ash constituents or inorganic matter is present in the mother's milk. This relationship is indicated in the following table taken from bulletin 201 of the Ohio Experiment Station:

SPECIES	Time in days for the new-born animal to double its weight	100 PARTS OF MILK CONTAIN			
		Protein	Ash	Calcium	Phosphorus
Man	180	1.6	0.2	.021	.022
Horse	60	2.0	0.4	.086	.057
Cow	47	3.5	0.7	.114	.087
Goat	22	3.7	0.78	.143	.122
Sheep ...	15	4.9	0.84	.178	.127
Swine	14	5.2	0.80	.178	.135
Cat	9.5	7.0	1.02	....	....
Dog	9	7.4	1.33	.321	.223
Rabbit ...	6	10.4	2.50	.636	.437

Ztschr. physiol. Chem., 27, 594.

It is to be observed that of the nine mammals mentioned, the young rabbit doubles its original weight in the shortest time, or in about six days. In this respect it stands next to a chicken, although the latter grows relatively faster. It is to be observed, also, that the more rapid the growth of the young, the more calcium and phosphorus there is in the milk, the phosphorus content of the rabbit's milk running up to .437 per cent.

Assuming that a rabbit and a chicken on account of the similarity in their rapidity of growth require practically the same amount of phosphorus, lime, etc, in their food, let us see how some of the feeding stuffs commonly used in feeding chickens compare in respect to the total ash constituents, phosphorus and lime with the amount of the same materials present in the milk of the rabbit. I have no figures showing the amount of solids in the milk of the rabbit, but assuming that there is double as much dry matter as in cow's milk, which must be approximately correct, then the dry substance of rabbit's milk would contain approximately 1.75 per cent phosphorus, 2.54 per cent calcium, and 10 per cent ash. Let us consider corn meal. In corn meal there is .13 per cent phosphorus, .03 per cent calcium and only .68 per cent ash. In the dry matter of rabbits' milk there is, then, more than ten times as much phosphorus, eighty times as much lime, and fifteen times as much total ash. In view of these facts, it is no wonder that corn meal when fed by itself is not a good food for growing chickens. Of course, if a chick fed on corn meal has access to an abundance of animal food, such as bugs and worms, cut bone, or beef scrap, all of which are rich in lime and phosphorus, then satisfactory gains can be made, as the materials of animal origin supply those ash constituents which are so decidedly deficient in corn meal.

Large Amount of Mineral Food Required.

It may be well to point out here that the requirements of a growing chick and a mature fowl differ somewhat in respect to mineral matter. A chick requires large amounts of lime and phosphorus or calcium phosphate, for the formation of bone and to enter into the composition of the tissues, while little of these materials are required by a mature fowl for mere maintenance. When fowls are laying, however, there is a demand for large quantities of lime used in building up the shell of the egg, and also for a smaller amount of phosphorus, as the yolk of an egg is a highly phosphorized substance.

The question now arises, can the ash constituents or inorganic substances which it is necessary to add to a grain

Putnam County, W. Va. Poultry Could be Raised Profitably in This Orchard in Large Numbers.

ration in order to make it a suitable food for growing chickens, be derived from any other source than materials of animal origin, such as beef scrap, granulated milk, or cut green bone. To answer this question we have very little or no data with direct reference to poultry, although some of the Experiment Stations are now at work on this problem, but some very interesting tests along this line have been reported recently by the Wisconsin Experiment Station in which young growing pigs were the animals experimented on. It was found that they have the power to make use of phosphorus and lime from inorganic sources, when the ration otherwise would be deficient in these constituents, so it appears highly probable that in raising chicks inorganic phosphates will be of great value especially when the ration is somewhat deficient in beef scrap, or other materials of animal origin, which are rich in phosphorus. For further discussion of this subject the reader is referred to Research Bulletin No. 1, Wisconsin Agricultural Experiment Station, Madison, Wisconsin.

Two Important Chick Diseases.

When chickens are raised in large numbers artificially, some of them are sure to die before they are more than a month old. If the number of deaths is excessive it is very important to determine the cause of the mortality. Frequently this can be determined by a simple post mortem examination.

Most young chicks die either through inflammation of the lungs or through non-absorption of the contents of the yolk sack or white diarrhoea.

Inflammation of the Lungs. In health the lungs of a chick are of a porous spongy nature, and bright scarlet in color. If the chick has caught cold and died from that cause the lungs, or at least portions of them, are apt to be soggy in texture and dark red in color. If the inflammation has continued for some days before the death of the chick, there are usually little lightish colored nodules filled with cheesy matter scattered through the lung tissue. For this condition of the lungs there is no remedy. Prevention is better than a cure.

Non-absorption of the Contents of the Yolk Sack or White Diarrhoea. Kill and examine two or three healthy chicks of the same age as those that die and compare the condition of the yolk sacks in the two cases. If the contents of the yolk sack is abnormal, being either too full of fluid matter in the case of very young chicks, or containing a considerable amount of cheesy substance in those that are older, and if the intestines, to a considerable extent, are empty, or distended with gas, together with general diarrhoeal conditions, it is probable that bacillary white diarrhoea is present. To determine the matter definitely requires a bacteriological examination.

White diarrhoea is a germ disease and seems to be transmitted to the chick through the egg, by infected breeding stock. The infected chicks, too, can spread the disease by means of bacteria present in their droppings. These may be taken into the digestive system of healthy chicks, thus spreading the infection. Chickens more than three or four days old, however, do not contract the disease in this way, so if a chick is hatched free from the disease and is kept from contracting it for three or four days it probably will remain healthy.

So far no remedy has been proposed. Preventive measure, however, are of value, and the following suggestions have been offered by the Connecticut Experiment Station, where this disease has been studied:

"**Prevention** Since the disease cannot, apparently, be transmitted through the food supply after the chicks have reached the age of three or four days, every means should be pursued to prevent the spread of the infection during this critical period. We suggest:

The segregation of the chicks in small lots during this interval.

Perfect disinfection and cleanliness of brooders or brood coops.

Food and water supplied in such a manner as to prevent contamination by the droppings.

The use in the brooder of a liberal amount of fine, absorptive litter which will quickly cover and seal up the droppings.*

Raise and maintain the vigor and vitality of the breeding stock and chicks by every reasonable means known to the poultryman."

***For this purpose we have used alfalfa meal with much satisfaction.**